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THESIS

DEVELOPING BEHAVIORAL METRICS FOR DECISION-MAKING IN MARINE CORPS SMALL-UNITS

by

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September 2013

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This thesis developed behaviorally anchored-rating scales (BARS) for use in evaluating Marine Corps small-units (SUs) during live and virtual decision-making (DM) training. Currently, the Marine Corps does not mandate the use of standardized metrics and processes for the evaluation and feedback during SU DM training scenarios. Often, evaluators assess trainee performance in uncertain situations based on gross outcomes rather than process-oriented measures. Properly developed and integrated into a training plan, BARS offers a novel solution to these constraints. The application of BARS has been explored in the law enforcement and medical domains and has been explored on a limited basis for infantry tasks. This effort proposed that observing SU leader's observable behaviors in context of their task performance would provide objective measures of DM. The first portion of this work was focused on the design and development of BARS specific for use during multiple IIT scenarios. The second phase of this research refined the initial BARS into six scenario-specific evaluation measurement tools. Additionally, this work provided an initial effectiveness evaluation of the refined BARS in operational training at the IIT. Results indicate that the BARS developed for this thesis have the potential to replace the nonstandard and subjective methods currently used for the evaluation of DM training in live and virtual environments.

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DEVELOPING BEHAVIORAL METRICS FOR DECISION-MAKING IN MARINE CORPS SMALL-UNITS

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ABSTRACT

This thesis developed behaviorally anchored-rating scales (BARS) for use in evaluating Marine Corps small-units (SUs) during live and virtual decision-making (DM) training. Currently, the Marine Corps does not mandate the use of standardized metrics and processes for the evaluation and feedback during SU DM training scenarios. Often, evaluators assess trainee performance in uncertain situations based on gross outcomes rather than process-oriented measures. Properly developed and integrated into a training plan, BARS offers a novel solution to these constraints. The application of BARS has been explored in the law enforcement and medical domains and has been explored on a limited basis for infantry tasks. This effort proposed that observing SU leader's observable behaviors in context of their task performance would provide objective measures of DM. The first portion of this work was focused on the design and development of BARS specific for use during multiple IIT scenarios. The second phase of this research refined the initial BARS into six scenario-specific evaluation measurement tools. Additionally, this work provided an initial effectiveness evaluation of the refined BARS in operational training at the IIT. Results indicate that the BARS developed for this thesis have the potential to replace the nonstandard and subjective methods currently used for the evaluation of DM training in live and virtual environments.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

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LIST OF ACRONYMS AND ABBREVIATIONS

AAR	After Action Review
ANSF	Afghan National Security Forces
AOA	Avenue of Approach
APA	American Psychological Association
ASVAB	Armed Services Vocational Aptitude Battery
BARS	Behaviorally-Anchored Rating Scales
C2	Command and Control
CARS	Cognitive and Relational Skills
CASEVAC	Casualty Evacuation
CCTV	Closed-Circuit Television
CDM	Critical Decision Method
CDT	Cognitive Demand Table
CMC	Commandant of the Marine Corps
COA	Course of Action
CONUS	Continental United States
C-OODA	Cognitive Observe, Orient, Decide, & Act
CTA	Cognitive Task Analysis
DoA	Department of Army
DoD	Department of Defense
EFP	Explosively Formed Penetrator
EOD	Explosive Ordnance Disposal
EUT	Expected Utility Theory
EXFILL	Exfiltrated
HPT&E	Human Performance, Training and Education
IE3DC	IED-Defeat Decision Cycles
IED	Improvised Explosive Device
IIT	Infantry Immersion Trainer
IRB	Institutional Review Board
KA	Knowledge Audit
LVC	Live, Virtual and/or Constructive

MAGTF	Marine Air-Ground Task Force
MCBCP	Marine Corps Base Camp Pendleton
MCWL	Marine Corps Warfighting Laboratory
MEB	Marine Expeditionary Battalion
MEDEVAC	Medical Evacuation
MEF	Marine Expeditionary Force
MEU	Marine Expeditionary Unit
MOUT	Military Operations on Urban Terrain
MSL	Maneuver Squad Leader
MSLMM	Maneuver Squad Leader Mastery Model
NAEP	National Assessment of Educational Progress
NCLB	No Child Left Behind
NCO	Noncommissioned Officer
NPS	Naval Postgraduate School
OGT	Ohio Graduation Test
OIF	Operation Iraqi Freedom
ONR	Office of Naval Research
OODA	Observe, Orient, Decide and Act
POO	Point of Origin
QRF	Quick Reaction Force
ROE	Rules of Engagement
RPD	Recognition Primed Decision
SAF	Small-Arms Fire
SAT	Scholastic Assessment Test
SJT	Situational Judgment Test
SME	Subject Matter Expert/Expertise
SNCO	Staff Non-Commissioned Officer
SOF	Special Operating Forces
Sqd	Squad
STO	Science and Technology Objective
SUDM	Small Unit Decision-Making
TECOM	United States Marine Corps Training and Education Command

TTPs	Tactics, Techniques, and Procedures
TVCS	Tactical Video Capturing System
T&E	Test and Evaluation
USAF	United States Air Force
USJFCOM	United States Joint Forces Command
USMC	United States Marine Corps
UXO	Unexploded Ordinance
WWI	World War I
WWII	World War II

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I. INTRODUCTION

The United States Marine Corps (USMC) has been fighting and defeating our nation's enemies for 237 years. Regardless of the clime or place, the Marine Air-Ground Task Force (MAGTF) places ever-increasing responsibility on its Marines, particularly at the non-commissioned and company officer grades in order to remain adaptable to any environment (Hannigan et al., 2012). The concept of the "Strategic Corporal," a term coined by Gen Charles C. Krulak, emphasizes that actions made by individual Marines at the tactical level can influence the operational and strategic levels of warfare (Krulak, 1999). This type of individual decision-making at the tactical level makes educating and training marines and sailors in ethics and decision-making in complex and uncertain environments imperative (Kobus, 2012). Concomitantly, a means to measure and evaluate a Marine's or Sailor's decision-making and leadership ability in such environments is critical to enabling the future success of the MAGTF (Dunford, 2011).

The ambiguous and complex nature of modern warfare puts a premium on small-unit leadership at the squad, platoon, and company organizational levels (Gideons, 2011). Leaders reacting to a dynamic and chaotic battlespace, which is compounded by geographic dispersion, mission diversity, adaptive adversaries, and rules of engagement (ROE) (Board, 2012), are required to make intelligent, timely, and situationally relevant decisions. Additionally, deficiencies in time and information further complicate a leader's ability to fully process and analyze the myriad of possibilities.

> On an important decision one rarely has 100% of the information needed for a good decision no matter how much one spends or how long one waits. And, if one waits too long, he has a different problem and has to start all over. This is the terrible dilemma of the hesitant decision maker. (Greenleaf & Spears, 2002, p. 36)

Marines and sailors need to be able to quickly and accurately make decisions in combat, despite the complexities, and instructors and supervising officers need tools to help them evaluate the trainees' ability to do so. The art and science of decision-making encompasses more than a decision maker's speedy computational prowess. Decision-making requires situational awareness of the problem at hand, along with the creative

means, informed by experience, education and intelligence, to achieve the desired solution (USMC, 1997).

Colonel John Boyd's (USAF) "Observe, Orient, Decide and Act" (OODA) loop is an abstraction of the decision-making cycle that is reliant upon an individual first observing the environmental conditions or cues. Once the individual has detected the cues in the environment, the Marine or Sailor must adjust his or her mental picture to the situational reality and then decide on a course of action or inaction (Angerman, 2004). This decision-making cycle is a descriptive framework that military leaders and organizations use to understand and analyze the human command and control (C2) system (Hannigan et al., 2012).

Decision-making theories and models are categorized as involving either analytical or intuitive strategies (Sjöberg, 2003). An example of an analytical strategy is found in the Vroom-Jago "Rational Decision" model (Turpin & Marais, 2004). Gary Klein's "Recognition Primed Decision" (RPD) model and Boyd's "OODA" theory are categorized as intuitive strategy models (Turpin & Marais, 2004). Analytical decision models are more appropriate for simple scenarios where time is sufficient to evaluate alternatives for a relatively few courses of action (COAs) and the decision maker has access to the information needed to make a decision. Intuitive decision models are more appropriate for complex or uncertain scenarios where deficiencies in time, information and/or resources will not impede the selection of a sufficient COA (Roth, 2004). Additionally, intuitive decision-making strategies take into consideration the operational factors experienced by deployed Marines and Sailors (Commandant of the Marine Corps, 2010B). Due to these factors, this research will focus on the intuitive strategies instead of analytical methods when discussing the decision-making process.

The Commandant of the Marine Corps (CMC), Gen. James F. Amos, established a set of priorities for the current and future outlook of the USMC. His third doctrinal priority is, paraphrasing, to improve training and experience levels for maneuver unit squad leaders (Amos, 2010). Additionally, the CMC specifically points out that the Naval Postgraduate School and marines attending the institution direct their individual studies to "ensure they align with USMC needs" (Amos, 2010, p. 14). Science and

Technology Objectives (STOs) codify these identified gaps and address them under the purview of the Office of Naval Research (ONR). Research conducted for this thesis will support the Human Performance, Training and Education (HPT&E) thrust, aligning with the Test and Evaluation (T&E) STO #2, "Small unit learning and performance assessment" (ONR, 2012).

Current operational training of Marine Company, Platoon, and Squad-based units is done on training ranges in Live, Virtual and/or Constructive (LVC) environments. The Infantry Immersion Trainer (IIT) located on Marine Corps Base Camp Pendleton (MCBCP), CA, is an example of a live and virtual operational training environment (Kobus, 2012). For this thesis research, the IIT on MCBCP served as the facility for observational data collection. Currently, IIT staff conducts subjective performance assessments, usually in the form of After Action Reviews (AARs). These AARs traditionally occur at the conclusion of a scenario or on an ad hoc basis at the discretion of the training unit (Kobus, 2012). While these subject matter experts (SMEs) provide critical expertise and insight, feedback tends to be limited (Kobus, 2012). Moreover, there are neither standardized metrics for evaluating the small unit's behavior while engaging in scenarios, nor standardized processes for providing feedback (Kobus, 2012). Including behaviorally-anchored metrics in the training and evaluation process at the IIT will improve feedback to trainees. Measuring the small-unit's performance in this context will improve assessments of decision-making in certain IIT scenarios, thus contributing to the standardization of Marine operational training (Kobus, 2012).

This thesis research is segmented into two phases, the knowledge elicitation phase and the observational data-collection phase. For the knowledge elicitation phase (phase one), semi-structured interviews were performed with SMEs to elicit information relevant to developing measures to assess performance. These SME interviews were used to develop a set of observer-based performance measures used in specific IIT related scenarios as a proof of concept.

The output from the knowledge elicitation phase (phase one) was used to develop a set of behaviorally-anchored metrics for use in evaluating the performance of Marine Corps squads engaging in training at the IIT. These metrics were used by the researcher

in the observational data collection phase to collect performance data at the IIT. The goal for this phase was to test the metrics developed in the first phase to determine if they provide objective and effective measures. Developing valid and reliable metrics will facilitate assessment of individual and collective performance and overall training effectiveness. "These measures will enhance and complement current subjective measures" (Kobus, 2012, p. 28).

Live and virtual-training environments such as the IIT provide a new approach to instruct, train and evaluate marines and sailors. Compared to traditional Military Operations on Urban Terrain (MOUT) facilities and ranges, these new training ranges offer more dynamic and immersive experiences approximating realistic combat environments (United States Joint Forces Command, 2011). The objective for this thesis research was to provide the evaluator a means to quantify decision-making performance. The benefit from this research is that it provides instructors behaviorally-anchored measures that can be used to provide specific relevant feedback to trainees. Through realistic training, Marines will be prepared for complex and ambiguous situations by leveraging proficiency in technical and tactical knowledge, while executing sound judgment in a decentralized manner (Conway, 2008).

II. BACKGROUND

A. HISTORY OF ASSESSMENTS

The sinking of the British passenger liner RMS Lusitania by a German submarine in 1915 (Lauriat, 1915), and the unrestricted German submarine campaign of 1917 (Tucker & Roberts, 2005) thrust the United States into the "War to End all Wars" of WWI (Jamieson, 1988, p. 101). Americans such as Robert M. Yerkes, president of the American Psychological Association (APA), were eager to aid the war effort. He quickly convened the APA in an effort to pool their collective knowledge, methods, and expertise in order to increase the efficiency and effectiveness of screening and assigning enlistees and officers to military positions (Kevles, 1968). Along with noted psychologists, Robert L. Thorndike, Lewis Terman, and David Wechsler, the APA created an alpha and beta assessment battery that would evaluate and then classify the intellectual potential of military enlistees and officer candidates (Kevles, 1968; Cardona & Elspeth, 2007). By 1976, these initial assessment tools were refined, and then formally presented as the Armed Services Vocational Aptitude Battery (ASVAB). Currently, the Department of Defense (DoD) uses "this test battery for both screening qualified candidates and assessing trainability for classified jobs" (Dubay, 2007, p. 14).

An assessment "determine[s] the importance, size, or value of" a process by an individual or organization ("Assess," n. d.). In traditional educational curriculums, assessments are characterized as having either a formative or summative format. The intent of both formats is to gauge the learner's comprehension of the curriculum and validate the instructor(s) or institution's method of delivering the education or training (Wiliam, 2000). The summative format is a judgment at a milestone in the learner's knowledge acquisition process (Taras, 2005). The formative assessment entails an iterative loop that adjusts and corrects a learner's gap or deviation in knowledge from an established knowledge standard (Taras, 2005). The intent of either assessment format is accountability to its internal (teachers, students, and parents) and external stakeholders (school boards, government, etc.) (Linn, 2000; Shepard, 2000A).

Historically, assessments have been used to reform a particular social policy, such as Head Start, after-school programs, school uniforms, or instructional strategy (Linn, 2000). The physical implementation of assessments is typically relatively inexpensive, transparent, and easily implementable which provides a smooth promotion and inclusion into educational environments (Linn, 2000). Figure 1 illustrates the evolving nature and application of assessments with regard to curriculum, function, and learning theory.
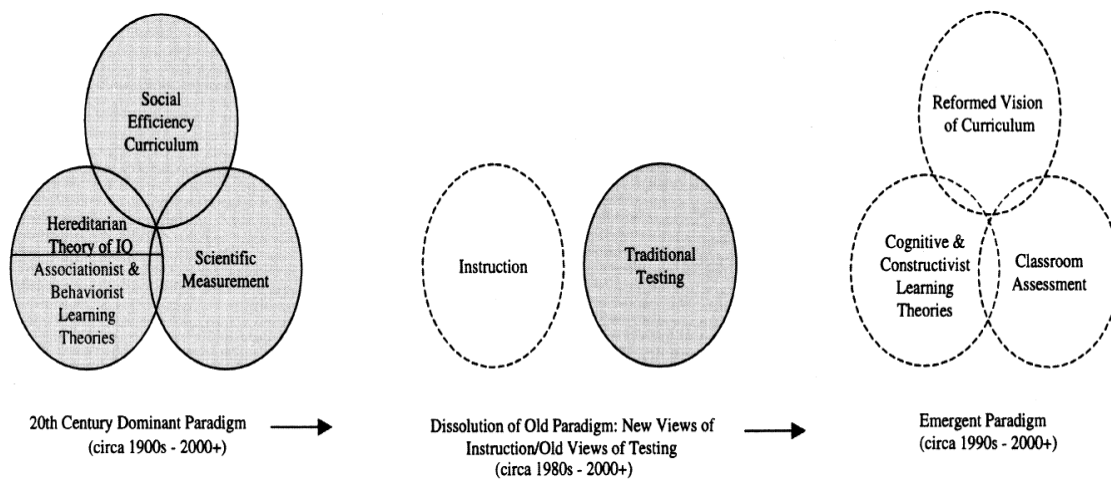
Figure 1.   The historical and evolving viewpoints of assessment, curriculum, and learning theory (From Shepard, 2000B, p. 4).

Twentieth century approaches to assessment viewed instruction as a process to eliminate inefficiencies from a particular learner's behavior (Shepard, 2000B). Under this paradigm, learners were expected to master all the basic domain knowledge through repetition exercises and thereby incrementally develop expertise (Shepard, 2000A). This linear approach to instructional assessment migrated into summative testing methodologies such as the Ohio Graduation Test (OGT) and the Scholastic Assessment Test (SAT) (List of Standardized Tests in the United States, n. d.).

The instructional assessment domain is currently undergoing a transformation in response to the policies in the 2001"No Child left behind Act" (Kim & Sunderman, 2005; Linn, Baker, & Betebenner, 2002; No Child Left Behind Act of 2001 (2002)). Additionally, the congressionally mandated National Assessment of Educational Progress (NAEP) instituted a national standardization protocol that enforces state education

performance requirements for pupils in primary and secondary schools (Swanson & Stevenson, 2002). These rules are based upon egalitarian principles that are agnostic to geographic, socioeconomic, and/or linguistic differences between diverse populations (Kim & Sunderman, 2005). Instituting a carrot-and-stick approach to reforming education and assessment means educators, pupils, and schools are being held accountable for the educational outcome of the pupil. Therefore, primary and secondary education will ideally provide pupils "a fair, equal, and significant opportunity to obtain a high-quality education and reach, at a minimum, proficiency on challenging state academic achievement standards and state academic assessments" (NCLB, 2001, Sec. 1001 [3]).

The domain of learning theory, and more specifically knowledge development, is evolving with advances in medicine, science, and technology (Dede & Barab, 2009; Osborne & Wittrock, 1983). Traditional associative and behaviorist approaches to learning and instruction are giving way to newer mental models based on cognitive and constructivist research and their applied learning theories (Anderson, Reder, Simon, Ericsson, & Glaser, 1998). These emergent approaches are less concerned with solely eliminating inefficiencies in the learner's behavior. Cognitive and constructivist approaches focus on tailoring knowledge development to the individual's social and cultural learning biases and aptitudes (Shepard, 2000B). This movement in learning science has promoted the integration of formative assessment methodologies in addition to, or in place of, traditional summative regimes (Harlen & James, 1997; Shepard, 2000A; Shepard, 2000B).

B. HISTORY OF THE AFTER ACTION REVIEW

The most valuable and impactful assessment used in operational training is the After Action Review, or AAR (Smith, Yates, Valdyke, Roby, & Denney, 2010). The AAR, as a training tool, came into existence approximately 45 years ago and was predicated upon two important influences (Morrison & Meliza, 1999). The first influence was S. L. A. Marshall's, "Island Victory: The Battle of Kwajalein Atoll." In this book, he employs "the interview after combat" method, where he recalls the "very words of the men who fought – and therefore a highly accurate account of exactly what happened, as one scene of stress and confusion

followed another" (Marshall & Dawson, 1944, p. xxi; cited in Morrison & Meliza, 1999). The other influence was the "performance critique" method (Morrison & Meliza, 1999). This was the primary means of delivering performance feedback prior to the development of the AAR. This was originally employed to determine battle damage assessments during simulated battles where the outcomes of the exercises were subjectively adjudicated by "human umpires" (Morrison & Meliza, 1999, p. 6). In the early 1970s, the performance critique method was determined to be an ineffective means to assess training units and enhance their performance goals. From this coalescence, the DoD developed the AAR methodology to provide feedback in a more constructive and non-punitive manner (Morrison & Meliza, 1999).

C.   AAR AND MILITARY TRAINING APPLICATIONS

In the military context, formative assessments are congruent with the AAR format (Morrison & Meliza, 1999; Rudolph, Simon, Raemer & Eppich, 2008). The AAR and its feedback mechanism afford individual and group learners a means to correct deviations in either an informal or instrumented (formal) manner (Kobus, 2012). In either AAR format, there must be a blending of training and assessment feedback that the instructor must weave into a narrative that the learner understands and then is responsive toward (United States Marine Corps Training and Education Command (TECOM), 2011). "Education' teaches [the learner] how to think, perceive, and make decisions while 'training' teaches what to think and do to make decisions" (TECOM, 2011, p. 18). The AAR must not be the means to solve the learner's "problem" or train to the explicit solution. The formative assessment format must allow the learner to perceive, comprehend, and then innovate beyond their friction and allow a suitable range of alternative actions, instead of a single "correct" decision (Kobus, 2012, p. 26–27).

In the AAR, the trainer must balance the desire to explicitly correct deviations or errors, thus circumventing the decision-making process of the learner. Instead, the trainer should ignore minor deviations that do not impact the final decision process and delay the expected errors that the learner has consistently made by offering timely, open-ended hints or leading questions. Only when delaying expected errors fail should the instructor intercede with a prompt that initiates the learner into self-assessment and correction. Depending on the constraints of the exercise, the trainer could engage the learner more

directly with explicit feedback on performance. This tactical change of explicitly interceding and guiding the training unit to a desirable end state would normally be driven by external real-world pressures (Lepper & Woolverton, 2002; Shepard, 2000B).

1. ASSESSMENTS ON MILITARY TRAINING RANGES

Currently, the DoD uses the AAR to evaluate trainee performance involving military training ranges (Frank et al., 2004). Operational training in LVC environments is advantageous to training conducted in expeditionary environments because of the prohibitive expense, and unmitigated risk to personnel, materiel, and/or resources (Ford et al., 2004; Boese, 2013). The USMC executes the majority of its operational training on air, naval, and/or ground training ranges throughout the continental United States (CONUS) and territories (Under Secretary of Defense (Personnel and Readiness), 2012). Additionally, selected training ranges in friendly foreign host nations are utilized to promote friendly military relations and enhance coalition training capabilities (Sanders, 1998). Military use of assessments and the operational training conducted on various training ranges share a common functional and mutually dependent end state (Lanman, Becker, & Samper, 2009).

a. USMC Training Ranges

The current range infrastructure utilized by the USMC is characterized by dispersed geographic locations, dissimilar capabilities and capacities with the requirement to support a broad spectrum of mission essential warfighter training (TECOM, 2006). Training ranges are classified by their particular size and/or level of the training unit (smallest to largest); specifically, individual level, unit level, Marine Air Ground Task Force (MAGTF) and Marine Expeditionary Unit (MEU) Level, and MAGTF Marine Expeditionary Battalion (MEB) Level (TECOM, 2006, p. II). Their central purpose and function is to train Marines collectively in the approximated operational environment that enables effective operations in complex and uncertain expeditionary environments (Conway, 2008). Future reference to Marine Corps training ranges will be specific to air/ground training ranges located in CONUS and Hawaii.

b.   *Infantry Immersion Trainer*

The original infantry immersion trainer (IIT) is located on training range "Area 62" on Marine Corps Base Camp Pendleton (MCBCP) (Babb, 2007). The IIT was conceptualized by then I Marine Expeditionary Force (I MEF) Commanding General James N. Mattis. He wanted and demanded industry, governmental agencies, and academia to construct a training environment that would prepare Marines for deployments to Iraq in support of Operation Iraqi Freedom (OIF). His training intent for the IIT was for Marines to be immersed with the "sights, sounds, smells and chaos of urban and close quarters battle so that their first real firefights were no worse than their simulations" (Muller, Schmorrow & Buscemi, 2008, p. 14).

In 2007, with support from the Office of Naval Research (ONR), Marine Corps Warfighting Laboratory (MCWL), and I MEF staff, the IIT concept became an operational reality (Muller et al., 2008; Schwetje, 2009). The central mission of the IIT is to "provide the most realistic combat conditions and settings to the small unit, in a virtual format, in order to teach and reinforce combat decision-making and small unit mission rehearsal" (Babb, 2007). Currently, there are two additional IIT facilities located on MCB Camp Lejeune, NC, and MCB Kaneohe Bay, HI. Training operations commenced at these installations on July and October, 2011, respectively. Both facilities operate independently of the other IITs with regard to their training concept of operations (Kobus, 2012). All future reference to the IIT will be specific to the MCBCP IIT.

c.   *Assessments at the Infantry Immersion Trainer*

Currently, assessments of unit performance during operational training exercises, particularly at the IIT, tend to be subjective (Kobus, 2012; Matthews & Beal, 2002). Moreover, there are neither standardized metrics (tools or applications) for evaluating the small unit's performance while engaging in scenarios nor standardized processes for providing objective feedback (Hannigan et al., 2012; Kobus, 2012). Additionally, IIT trainers conduct performance assessments on an ad hoc basis. While these subject matter experts (SMEs) provide critical expertise and insight, feedback tends to be limited in nature. The trainers debriefing narrative identifies "what happened during the scenario, why it happened, and how it should be done in similar situations" (Kobus, 2012, p. 24).

IIT trainers and staff utilize different assessment techniques for the pre-training, training, and post-training exercise phases. In the pre-training phase (prior to training execution), situational judgment tests (SJTs) are used to assess trainee courses of actions (COAs) via scenario-based problems to resolve training effectiveness issues (Kobus & Viklund, 2012). Training effectiveness issues pertain to "decision-making, tacit knowledge and practical 'know-how' domains" (Kobus, 2012, p. 28). During the training phase, trainers provide "as needed" performance assessments via declarative verbal statements. This feedback is provided by an individual lead trainer or through multiple trainers working in teams (2–3 trainers). Prompts providing guidance are normally provided while walking alongside the training unit (Kobus, 2012). During the post-training phase, formative assessments are conducted in one of four AAR formats: Hot Wash, Informal AAR, Contour Camera instrumented AAR, or tactical video-capturing system (TVCS)/Video Flashlight instrumented AAR (Kobus, 2012; "Contour (camera system)," n. d.). These formats are described in the next section.

d.   *After Action Review at the Infantry Immersion Trainer*

IIT trainers use four AAR formats to assess and debrief the training units' performance. The least formal, the Hot Wash, is generally performed when a more structured method is not required, usually with unit members forming a circle formed around the trainer. The trainer briefly provides his evaluation regarding the unit's performance by highlighting his positive and negative observations of the exercise. This is followed by the trainer explaining corrective actions for observed faults regarding the unit's tactics, techniques, and procedures (TTPs). This type of AAR usually takes no longer than 10 minutes (Kobus, 2012).

The informal AAR extends the Hot Wash with a few notable additions. This method usually employs a 3-D block model to visually depict the eagle's eye view of the training area. The alternative to the 3-D block model is a projection of the training area on a television screen or computer monitor (Kobus, 2012). The training unit members, particularly the individual squad and/or platoon members, are the focus of this type of AAR. The trainer poses probing questions to elicit feedback from all members of the unit in order to share and hear all relevant perspectives pertaining to critical errors

observed in the exercise. The goal of having each member share their perspective is to openly discuss their thought processes and decision-making actions (Department of the Army (DoA), 1993; Kobus, 2012). This type of AAR usually requires no longer than 20 minutes (Kobus, 2012).

The next two types of AARs, the Contour Camera instrumented AAR and TVCS/Video Flashlight instrumented AAR only differ regarding the way they collect video and audio, the system's processing time, and viewing perspective ("Contour (camera system)," n. d.; Kobus, 2012). The TVCS/Video Flashlight and Contour Camera instrumented AARs are both conducted in the same structured classroom environment (Kobus, 2012). The Video Flashlight systems and TVCS are specifically used during phase I and phase II, respectively (Kobus, 2012). The Contour Camera approach can be used in either phase I or phase II. In the TVCS/Video Flashlight method, independent camera operators and video technicians use a closed-circuit television (CCTV) computer network to capture video streams from myriad cameras throughout the phase I/II training areas. Video technicians and camera operators work closely with trainers who are out with the training units, to mark and save important video selections to be used in PowerPoint presentations in the AAR. The total video processing time required, before the data can be used for the AAR, ranges from 20–50 minutes after each run, a significant delay which impacts the number of training runs that can occur in a day (Kobus, 2012).

The Contour Camera method is a different approach to capturing video. The trainer employs a small handheld camera and selects only those relevant video streams that will provide the maximum value to the training audience. The video streams are then directly downloaded from the memory of the Contour Camera to the classroom computer used for the AAR. Compared to the TVCS and Video Flashlight system processing time, the required time to completely process the selected video streams is approximately five minutes. Due to the operational requirements of the training units and the advantage presented by the Contour Camera's processing time, the Contour Camera instrumented AAR method is now the preferred method of instrumented AARs. The training unit uses the TVCS/Video Flashlight instrumented PowerPoint presentations for archive and complementary training purposes.

12

D.   CURRENT CAPABILITY GAP IN ASSESSMENTS IN THE DOD

The USMC and the Department of the Navy have recognized specific gaps in the manner in which we evaluate and train our Marines and Sailors, particularly in live, virtual and constructive (LVC) environments. Both the Marine Corps and the Navy face difficulties in conducting objective evaluations of the effectiveness of training systems and training environments in terms of achieving training objectives. This ability to objectively evaluate Marines and determine their level of mastery of the subject matter has been identified as a gap in current performance assessment methods that include an AAR or in the assessment process in general (Kobus, 2012; ONR, 2011).

Including behaviorally-anchored rating scales to objectively measure if, or how well, training objectives were met is one method to overcome this gap. These scales can be used to measure the performance of the training unit and the results can either be provided during the AAR or reviewed by the unit leader independent of the AAR process. This discretion afforded to the training unit and its operational tempo provides flexibility within the unit leader's training timeline. However, the more effective method of quickly assessing the unit's level of mastery of training objectives would involve incorporating this feedback as part of the AAR. Development of valid and reliable measures and metrics will facilitate the assessment of individual and collective performance and overall training effectiveness. "These measures would enhance and validate current subjective measures" (Kobus, 2012, p. 28).

E.   MOTIVATION AND PURPOSE OF RESEARCH

Research in the domain of performance assessment and its impact on Marines was motivated by a strong desire to have a positive effect on the Marine Corps. Aligning this interest in performance assessment with a documented Marine Corps gap, adheres to the CMC's guidance that Naval Postgraduate School (NPS) Marines conduct their thesis research in areas that "align with the USMC needs" (CMC, 2010A, p. 14). The objective of this research was to provide military trainers with behaviorally-anchored measures that can be used to provide specific feedback to trainees. Research conducted for this thesis has contributed to developing tools and methods to quantifiably assess the small-unit leader's decision-making abilities.

F.   BENEFITS OF RESEARCH

Live and/or virtual-training environments such as the IIT provide a novel approach to train and evaluate Marines and Sailors in a dynamic, immersive environment approximating realistic combat environments (Smith et al. 2010). The results of this research provide the trainer with measures that can be used to quantify decision-making performance. Current budgetary conditions experienced by military and civilian leaders, necessitate an effort to maximize efficiencies in existing programs and organizations (Bilmes, 2013). Inculcating the lessons learned from operational training exercises into subsequent training evolutions will afford greater skill retention in the individual and collective warfighting skill sets and use military budgets in a more efficient manner (Boese, 2013).

III. LITERATURE REVIEW

A. COGNITIVE AND CONSTRUCTIVIST PSYCHOLOGY

In the online article "More Complex Than a Galaxy" – New Insights Into the Enormous Biochemical Complexity of the Human Brain, Sir Roger Penrose was referenced comparing the complexity of the human mind to that of the galaxy. He said, "consider the human brain[,] if you look at the entire physical cosmos, our brains are a tiny, tiny part of it. But they're the most perfectly organized part. Compared to the complexity of a brain, a galaxy is just an inert lump" (as cited in www.dailygalaxy.com, 2012). To better understand the human mind, modern technology and science have deconstructed the brain's organic matter into its biochemical and genetic underpinnings (Hedden & Gabrieli, 2004). While these endeavors have advanced our contemporary understanding of the human mind and its capabilities, there is a plethora of outstanding questions regarding its cognitive processes (McGinn, 1989). Psychology was developed as a means to comprehend these cognitive processes, the mind's relationship to human behavior, and its connection with the external environment and society (Anderson, 2009).

Our modern understanding of the human mind and cognition came from centuries of philosophical literature, theoretical and empirical research, and advancements in technology and neuroscience (Finger, 2001). Ulric Neisser formalized the domain of cognitive psychology with his 1967 book, "Cognitive Psychology" (Neisser, 1967). Neisser's work was fundamentally influenced by Noam Chomsky's 1959 critique of B.F. Skinner's "Verbal Behavior" (world's leading behaviorist theorist's book on language). In his assessment of Skinner's work, Chomsky provided an "effective refutation of the behavioristic approach to language" (Neisser, 1967, p. 246). Neisser presented cognitivism as a more suitable and holistic approach to knowledge elicitation. He emphasized that a strict adherence to behavioral response or association to external stimulus was insufficient to explain the mind's mental processes (Neisser, 1976).

Nessier defined cognition as the "sensation, perception, imagery, retention, recall, problem-solving, and thinking" aspects of mental processes (Neisser, 1967, p. 4). The

cognitivist "emphasize[s] individual thinkers and their isolated minds" in the absence of, "the social nature of cognition and meaning" (Jonassen & Land, 2000, p. 26). A central tenet of cognition is metacognition or "Knowing about Knowing" ("Metacognition," n. d.).

> Metacognition refers to one's knowledge concerning one's own cognitive processes or anything related to them, e.g., the learning-relevant properties of information or data. For example, I am engaging in metacognition if I notice that I am having more trouble learning A than B; if it strikes me that I should double check C before accepting it as fact. (Nisbet & Shucksmith, 1984, p. 6)

Metacognition is evident when learners engage in training involving ambiguous scenarios with insufficient information. Effective outcomes are achieved when learners comprehend what is necessary to overcome the obstacle(s) to achieving their objectives and adapt their decision-making strategies accordingly (Morrison & Fletcher, 2002; Fortunato, 1991). Training conducted at the infantry immersion trainer (IIT) Camp Pendleton, CA, employs this cognitivist approach (Kobus & Viklund, 2012).

Cognitivist theory evolves into the Constructivist paradigm by incorporating the internal symbolic meaning of external social and environmental relationships. The constructivist rejects the notion that the learner perceives reality from the external environment; rather reality is internally constructed based upon the learner's perceptual experiences (Cooper, 1993). "Understanding is an individual construction, we cannot share understandings but rather we can test the degree to which our individual understandings are compatible" (Savery & Duffy, 1995, p. 1). During after action reviews (AARs), Marines verbally recollect the events of the scenario and present their interpretations of reality. Providing multiple facets of understanding and perspective enhances the shared understanding of events. This dissemination of various perspectives fosters development of common situational awareness among the individual Marines and affords them the opportunity to iteratively correct their misinterpretations of events presented in the training scenario (Smith et al., 2010).

**B.   ADDITIONAL   IMPLICATIONS   OF   COGNITIVE   AND
CONSTRUCTIVIST PSYCHOLOGY**

Cognitive and constructivist science naturally apply to the fields of educational, abnormal, social, developmental, and personality psychology ("Cognitive Psychology," n. d.). These specializations within psychology provide a broader applied discipline involving "the scientific study of the behavior of individuals and their mental processes" ("Psychology," n. d.). Due to the limited scope of this thesis, the focus of this chapter will be on cognitive and constructivist influences on educational and social psychology.

1.   Educational Psychology

In instructional environments, learners and instructors inherently possess a variety of biases, aptitudes, experiences, and sociocultural backgrounds. Instructional design of the learning environment and the relevant cognitive learning theory must be tailored according to these individual differences (Bereiter, 1990; Brook & Ross, 2002). This dynamic, current learning theory is divided into three levels of learning strategies. At the lowest level are learning theories based on genetics and neuroscience. Theories based on a psychological context constitute the medium level and philosophical and secular based contexts comprise the most complex and highest level of learning theories (Brook & Ross, 2002). Categorization in this manner aids facilitation of an optimal learning strategy, however the strategy does not include the additional and necessary external relationships included in constructivism. The intention of this discussion is not to highlight the differences or refute the merits of cognitivism; rather the goal is to emphasize their complementary natures (Bereiter, 1990). Both the cognitivist and constructivist approaches present an end state where the learner perceives, analyzes, comprehends and then decides on suitable courses of actions (COAs) (Gelder, 2005). The optimal outcome of either approach is an effective byproduct that is efficiently employed by the instructor.

2.   Social Psychology

Humans are intrinsically social creatures and are beholden to societal norms and traditions. Comprehending verbal and non-verbal interactions (such as, gesture, body

language, posture, tone of voice or facial expressions) is essential to form social identity and relationships with individuals and groups (Howard, 2000). Social psychology is "the branch of psychology that studies the effect of social variables on individual behavior, attitudes, perceptions, and motives [, and] also studies group and intergroup phenomena" ("Social Psychology," n. d.). Social psychologists attempt to understand individual and group social interactions through cognitivist and constructivist paradigms (Reich, 2003; Reicher, 2004).

The concept of identity is critical to social standing and purpose within the group. Organized individuals have a cognitive need to efficiently categorize individuals, groups, events, and objects in order to reduce their cognitive workload (Howard, 2000). In highly organized groups such as Marine squads and platoons, comprehending each Marine's role and function is essential to mission accomplishment. These classifications aggregate complex and fluid relationships into discrete elements which aid in recollection and utility. Marine units operating in highly complex and/or ambiguous situations rely on this identity simplification as a means to mutually support common objectives (Zaccaro, Rittman, & Marks, 2002).

> Cognitive readiness [refers to] the mental preparation (including skills, knowledge, abilities, motivations, and personal dispositions) an individual needs to establish and sustain competent performance in the complex and unpredictable environment of modern military operations. (Morrison & Fletcher, 2002, p. ES-1)

Within the cognitive readiness domain, there are generally accepted characteristics or heuristics that support effective decision-making. The following paragraphs describe the United States Marine Corps (USMC) cognitive readiness initiatives related to decision-making at the small unit level.

3.   United States Marine Corps Cognitive Readiness Initiatives and Research

In 2008, Commandant of the Marine Corps (CMC), Gen. James T. Conway (USMC), promulgated his "vision of the future Corps and a plan for creating the Marine Corps of 2025" (Conway, 2008, p. 3). This document informed Marines, combatant

commanders, and civilian leadership of the future direction the Marine Corps would provide to national defense. Additionally, it prioritized strategic objectives in order to "respond rapidly and decisively to crises anywhere in the world" (Conway, 2008, p. 14). One of these objectives established the need to train, educate, and prepare Marines for expeditionary operations in challenging environments. This Marine Corps document maintains that additional resources provided to noncommissioned (NCO) and junior officer grades will assist acclimatization to decentralized combat operations. This professional military education will condition ethical and sound decision-making skills in small-unit leaders.

The Marine Corps Vision & Strategy 2025 compendium is a planning document that will be promulgated in the following years in order to bring the CMC's intent from concept to reality. The implementation plan organized this strategy into three future years defense plan groups: "near-term: present [2008] – 2011; mid-term: 2012 – 2016; and far-term: 2017 and beyond" (Conway, 2008, p. 1). The document's first task directed the development of diverse approaches to NCO and junior officer intuitive decision-making. Consistent with Klein's naturalistic decision-making paradigm, small unit leaders will be trained to effectively recognize cues and patterns from the cultural and environmental terrain in order to acquire expertise. Current and emergent decision-making initiatives were codified in this implementation guidance (Conway, 2008).

In January 2011, the small unit decision-making (SUDM) initiative, under the purview of United States Marine Corps Training and Education Command (TECOM), conducted a workshop that focused on identifying tools, techniques, and procedures to support the SUDM goals (TECOM, 2011). The goal of the SUDM initiative is to accelerate cognitive readiness in novice small-unit leaders and inculcate its tenets in their subordinates (Schatz, et al., 2012). The SUDM workshop brought together leading cognitive researchers, scientists, and academics along with Marine officers who work in PME development and instruction. Workshop participants collectively agreed that the SUDM initiative and its goals would only be achieved through sustained planning and commitment. Additionally, they identified five competencies of cognitive readiness that support effective decision-making.

As listed and defined in Table 1, these cognitive readiness competencies (indicated by the shaded cells) are sensemaking, adaptability, attention control, metacognition, and problem solving (Schatz, et al., 2012; TECOM, 2011). Table 1 also includes definitions for ten cognitive and relational skills (CARS) (indicated by the non-shaded cells) which represent a finer resolution of the five cognitive competencies and "indicate decision-making proficiency" (Ross et al., 2012, p. 1–2; TECOM, 2011). Each of the cognitive competencies and CARS represent different dimensions of cognitive readiness. Each attribute addresses a particular gap of decision-making during military operations.

Table 1.   TECOM Small Unit Decision-Making Cognitive Competencies and CARS (From Ross et al., 2012, p. A2-A14).

Sensemaking: The cognitive process, driven by a specific goal, of filtering information for relevancy and using it to construct and continually assess an explanation of the broad or specific situation, often in the form of a story, in order to understand how and why the situation evolved and anticipate what might happen next.
Perspective Taking: Visualizing the situation from another's viewpoint and assessing his or her motivations and objectives, to predict his or her future actions and proactively position for or take advantageous action.
Analytical Reasoning: Critically and deliberately examining, assessing, and critiquing one or more alternatives or assumptions in the context of specified goals (e.g., the mission) and against a set of evaluative criteria (e.g., intent, timing, resources, or ROE).
Anomaly Detection: Critically and deliberately examining, assessing, and critiquing one or more alternatives or assumptions in the context of specified goals (e.g., the mission) and against a set of evaluative criteria (e.g., intent, timing, resources, or ROE).
Situational Assessment: Analytically or intuitively identifying and collecting information from multiple available sources, including one's own knowledge, to analyze relevant factors of METT-TC (mission, enemy, terrain and weather, troops and support available, time available, civil considerations) and construct an understanding of the situation to support a specific task or goal.
Adaptability: Fluidly modifying or changing one's planned actions when the situation has changed from what was expected, or when the typical approach or plan is rendered less effective than necessary.
Situational Assessment: Analytically or intuitively identifying and collecting information from multiple available sources, including one's own knowledge, to analyze relevant factors of METT-TC and construct an understanding of the situation to support a specific task or goal.
Cognitive Flexibility: Applying knowledge and principles of tactics and leadership differentially based upon the unique demands of the situation. Applying knowledge learned in one context to multiple relevant contexts.
Ambiguity Tolerance: The ability to calmly withstand and operate within uncertain environments by delaying drawing a conclusion or making a decision, or by making assessments and decisions in the face of uncertainty.

Attentional Control: Activities related to maintaining a focus on mission completion despite distracters including stress, boredom, fatigue, and emotion.
Resilience: Overcoming the stress, fatigue, emotion, or pain associated with a current or past event or situation in order to maintain or return to effectiveness as a leader and decision maker.
Self-Regulation: Monitoring, assessing, and adjusting one's own behavior and its effects in order to impact the situation in a way that supports mission, unit, or training goals.
Metacognition: Activities related to considering one's own thought processes, including assessments of strengths and limitations or developmental needs, in support of performing or learning the job.
Self-Awareness: Conscious knowledge of one's own character, motives, knowledge base, and skill set in order to request information or assistance when the requirements of the situation call for capabilities beyond one's current abilities.
Problem Solving: Identification, definition, examination, prioritization, and resolution of situations that impede task or mission accomplishment.
Analytical Reasoning: Critically and deliberating examining, assessing, and critiquing one or more alternatives or assumptions in the context of specified goals (e.g., the mission) and against a set of evaluative criteria (e.g., intent, timing, resources, or ROE).

Proficiency in each of the cognitive competencies and CARS will enhance and support the decision-making performance of the individual unit leader (Ross et al., 2012). Performance in this context does not exclusively apply to the training and/or garrison environment. Increasing the unit leader's performance in the training environment must have a positive correlation with expeditionary operations (Morrison & Fletcher, 2002). Attaining a level of competence in cognitive readiness should have an equal impact on operational effectiveness (Walsh & Shingledecker, 2006). Cognitive readiness is viewed as an interventional process which is assessed and measured against its product (Morrison & Fletcher, 2002).

C.   DECISION-MAKING THEORIES

Cognitive readiness is a concept that provides a set of attributes that can be used to prepare Marines to function effectively given the external influences from the environment. The decision to act or not act in operational environments is pivotal given the life and death nature of combat. Decision-making theories promote an understanding of individual and organizational decision-making processes with respect to their outcomes. Decision-making theories discussed in the remainder of this chapter will focus on intuitive strategies.

In decision-making situations that are extremely complex, ambiguous, or time-constrained, a more streamlined decision-making process is typically employed. The rational decision-making approach is not applicable for highly uncertain or time constrained decision-making situations. In fast-paced, uncertain decision-making situations a "satisficing" decision strategy is employed (Simon, 1957, p. 204–205). Satisficing reduces the learner's cognitive workload by shedding non-essential tasks from consideration and allows the learner to focus on the first sufficient COA rather than the optimal. The learner's pattern recognition capability is an important discriminator between the decision-making abilities of a novice and that of an expert. The following discussion of decision-making theories is not meant to be all-inclusive; rather theories discussed in the following sections are considered to be most applicable to this thesis research.

1.   Prospect Theory

Through much of the 20th century, decision-making theory was dominated by expected utility theory (EUT) (Kahneman & Tversky, 1979). EUT, postulated by Bernoulli in 1738, and later refined in 1947 by Von Neumann–Morgenstern, explained individuals in terms of the "rational decision maker" ("Expected Utility Hypothesis," n. d.; "Von Neumann–Morgenstern utility theorem," n. d.). The rational or normative model of decision-making described how individuals probabilistically decided on the most preferred action given all the information. While concise and explanatory, the theory's rationale did not provide an adequate explanation for decision-making situations that involve uncertainty and preference. In 1979, Kahnman and Tversky published a critique of EUT through their prospect theory of decision-making. This theory's critique of EUT was based on empirical examples of economic behavior related to gambling and insurance (Kahneman & Tversky, 1979). Prospect theory fundamentally contributed to decision-making and "demonstrate[d] that human judgment arises from qualitatively different processes than suggested by normative theories, and argue[d] that heuristics would provide a better starting point for the development of psychological theory" (Phillips, Klein, & Sieck, 2004, p. 297–298).

2.   Recognition-primed Decision Model

In 1989, the recognition-primed decision (RPD) model was introduced by Klein, Calderwood, and Clinton-Cirocco. The model explains how people make decisions expeditiously without comparing multiple options. It describes a naturalistic method of recognizing the "plausible [and suitable choice] as the first one to consider" (Ross, Klein, Thunholm, Schmitt, & Baxter, 2004, p. 6). Klein and associates developed the RPD model after observing experienced firefighters and interviewing them regarding their decision-making processes. They discovered that these firefighters never made explicit decisions; instead they instinctually acted upon the ground truths of the situation (Phillips et al., 2004). That is to say, firefighters were able to recognize key aspects of the situation, based on prior experience with similar situations, and were able to come up with a workable solution. Through experiential recognition, firefighters recalled previous similar events, their associated solutions, and implicitly decided upon the most workable COA.

As depicted in Figure 2, two critical components of the RPD model are situation assessment and mental simulation. Both processes provide the means to develop a particular COA and assess its validity. The pedagogical intent of RPD is to condition individuals to effectively synthesize meaningful connections from previous experiences, and provide timely and efficient correlations to the current solution space. When the decision maker uses a RPD strategy he/she does not systematically process all combinatorial paths or probabilities in order to rationally decide; rather using a RPD decision strategy entails selecting a COA that suffices given the limitations and constraints of the real-world (Klein & Klinger, 1991).
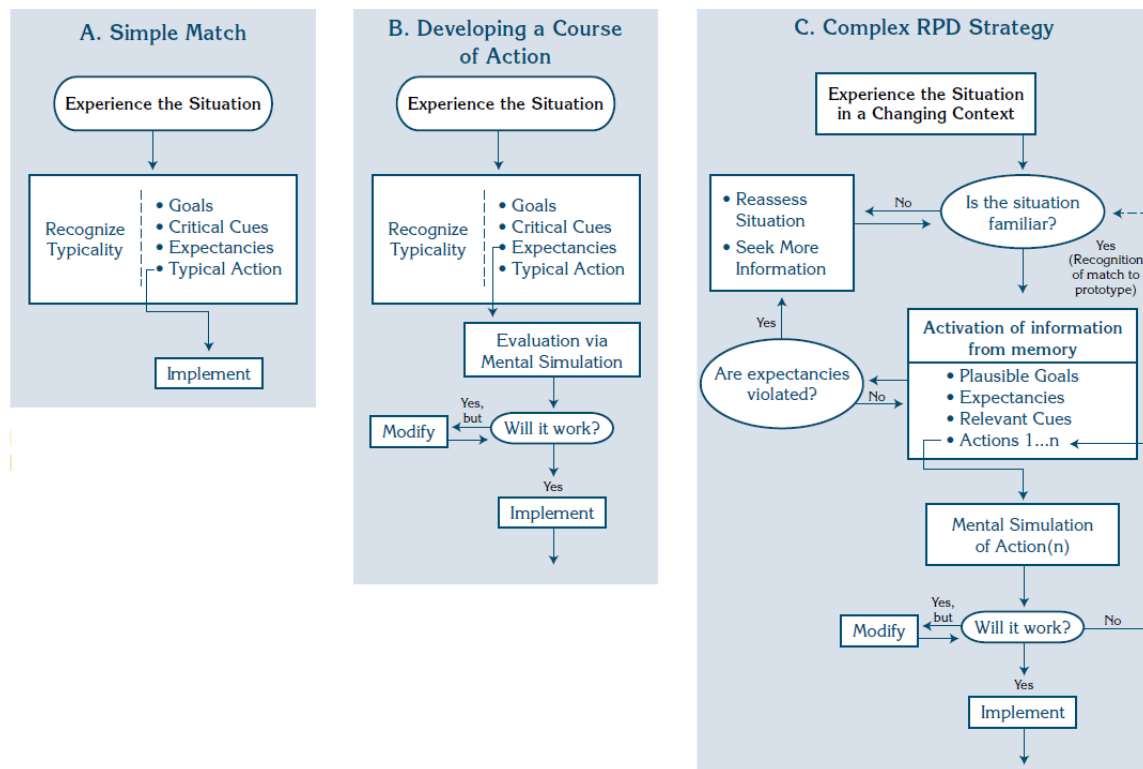
Figure 2.   RPD Model (From Klein and Klinger, 1991, p. 18).

3.   Observe-Orient-Decide-Act Loop

In 1977, the observe-orient-decide-act (OODA) loop, or Boyd's theory, was first presented in Col. John R. Boyd's (USAF), "Patterns of Conflict" (Osinga, 2005, p. 2; Boyd, 1986). This theory represented the culmination of Boyd's work regarding rapid

decision-making in uncertain and competitive environments. Boyd's theory describes the individual's decision-making cycle as the means to adapt, maneuver, and survive in a belligerent and resource-constrained environment (Osinga, 2005). Boyd describes this competition as a contest of wills, where participants prove to be successful or unsuccessful relative to the timeliness and acuity of their decisions (Boyd, 1976).

As depicted in Figure 3, during the observation stage, perceived sensory information from the external environment is processed and provides the necessary input for the orientation stage. The individual's experiences, biases, and background (physical, moral, and cultural) provide the necessary contextual reference and meaning for that information. The synthesized product is then forwarded to the decide stage, where judgment and deliberation are used to either reject or accept the COA. Once the COA is implemented, subsequent feedback loops ensure the actions are aligned with the decision made (Ullman, 2007).
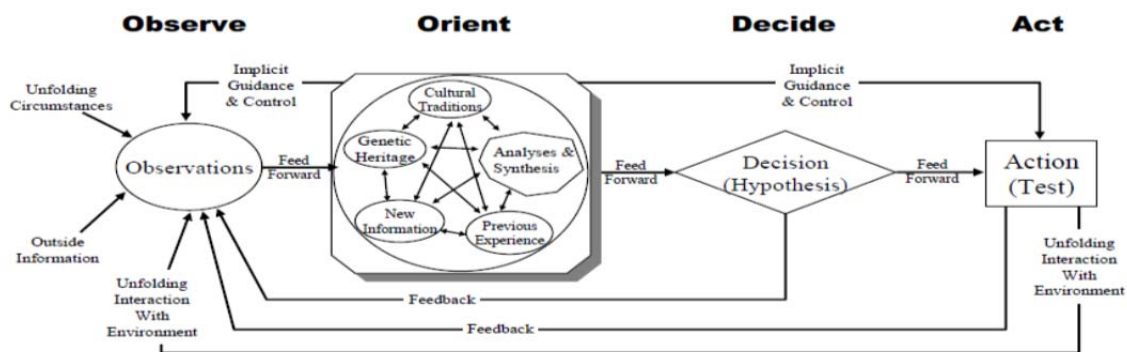
Figure 3.   Boyd's OODA Loop (From Ullman, 2007, p. 2).

4.   Cognitive Observe-Orient-Decide-Act Model

The cognitive observe-orient-decide-act (C-OODA) model is a natural extension of the OODA Loop model. As shown in Figure 3, Boyd's model was a "high-level abstraction of the decision cycle" (Hannigan et al., 2012, p. 6). The critical limitation of the OODA Loop was its presentation of the cognitive decision-making process. The original model was deficient in ascertaining the necessary cognitive requirements used to

identify the "dynamic properties of the decision-making task" (Breton & Rousseau, 2007, p. 243). Additional limitations regarding solitary input channels and granularity of decision-making expertise required further research (Hannigan et al., 2012).

The C-OODA model resolves the limitations noted above by integrating three applicable cognitive theories into the observation, orientation, and decision phases of the OODA model: (the act phase is purposely excluded due to the additional resource and skill requirements) (Hannigan et al., 2012). The C-OODA loop integrates Treisman's feature integration model, Endsley's model of situation awareness, and the RPD model as the observation, orientation, and decision phases respectively (Endsley, 1995; Hannigan et al., 2012; Klein, 1988; Treisman & Gelade, 1980). As depicted in Figure 4, the C-OODA loop incorporates a higher- and lower-level of cognitive processing. The lower-level processing applies uniformly to all skill levels (novice to expert decision makers), while the higher-level processing is apparent when proficiency and expertise mature (Hannigan et al., 2012).
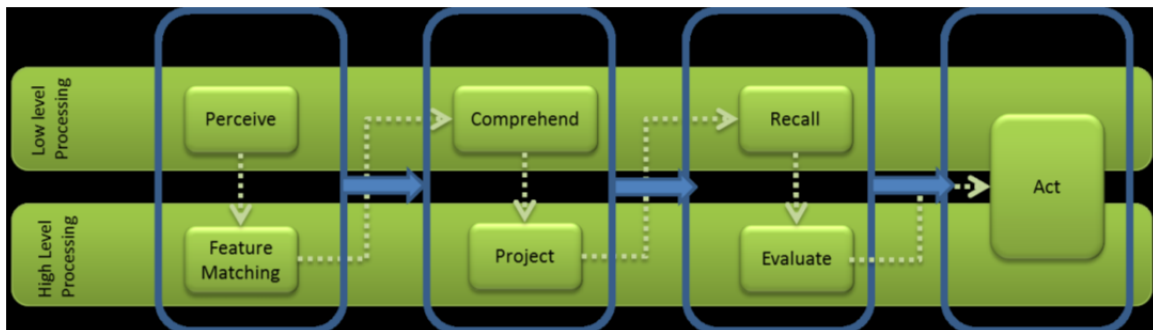
Figure 4.   C- OODA Loop (From Hannigan et al., 2012, p. 7).

As depicted in Figure 4, lower-level mental processing of perceived sensory stimuli occurs through feature matching and experiential association. Correlated objects (information) of interest are filtered out and forwarded to the next phase of the C-OODA loop where further processing of the objects will occur (Treisman & Gelade, 1980). Once the selected information is forwarded to the orientation phase, lower-level processing and comprehension of the information's importance, priority, and relevance occur (Endsley, 1995). Once the information is comprehended, and then referenced with

27

respect to the individual's norms, goals, and biases, relationships are established to facilitate projection of the individual's knowledge. Finally, information is forwarded to the decide phase, where the decision maker becomes cognizant of the information's relationship with respect to its importance or familiarity (Klein & Klinger, 1991). Once that understanding is achieved, individuals must evaluate the potential COA and the end state it will produce. Once this COA's evaluation process is complete and the COA's decision criterion is met, the COA is forwarded to the act phase.

5. Maneuver Squad Leader Mastery Model

The Maneuver Squad Leader Mastery Model (MSLMM) is a "five-stage descriptive model" that is "designed to (1) provide insights into how individuals progressively develop into high performing maneuver squad leaders, and (2) provide implications for what should be assessed and how during development" (Ross et al., 2012, p. 2). The model was developed under TECOM sponsorship for the SUDM initiative. The goal was to explain the process of optimizing attributes of expertise and decision-making competence as a "maneuver squad leader" (Ross et al., 2012, p. 1). The model can be used to assess the maneuver squad leader (MSL) across nine performance areas via five cognitive competencies and ten CARS (see Table 1.).

Behaviorally-anchored rating scales (BARS) that classify observable behavior with quantitative scales are incorporated in the MSLMM (Ross et al., 2012). The MSLMM addresses the need to describe the decision-making process with respect to the maneuver squad leader through incremental stages (novice to expert). BARS used in the MSLMM were generated through the situational judgment test and decision requirements interview instruments. The MSLMM requires future pilot studies to refine the assessment battery (incorporating BARS) beyond the currently restricted academic domain (Ross et al., 2012).

D. PERFORMANCE MEASURES DEVELOPMENT

The goal of this thesis is to develop performance measures that provide the evaluator a more objective means than currently used to assess the decision-making of Marine squad leaders in training environments. Assessing individual and unit

performance is "an essential part of team training and training research" (Shanahan, Best, Finch, & Sutton, 2007, p. 1). Factors that influence individual and unit performance and operational effectiveness can be qualitative or quantitative, singular or complex in nature (Schwab, Heneman, & DeCotiis, 1975). Examples of these factors that influence individual and unit performance are explained in the cognitive readiness section of this chapter. While the list of attributes in Table 1 is not all-inclusive, it does provide examples of cognitive and behavioral attributes used in the assessment and analysis of decision-making.

This thesis views performance measures through the prism of individuals operating in organized units. Individuals effectively operating in organized units should exhibit competence related to "(1) information exchange, (2) communication, (3) supporting behavior, and (4) initiative and leadership" (Shanahan et al., 2007, p. 5). These behaviors and the underlying cognitive processes that support these behaviors must be assessed within the context of the task, objective, and the environment where the task was performed (Phillips, Shafer, Ross, Cox, & Shadrick, 2006A). Diagnostically, the behavior must be distinct enough to be discriminable, while selective enough to allow for an acceptable amount of variability from the target audience (novice to expert). The behavioral assessment and its correlated metric must provide the evaluator the means to succinctly and efficiently annotate, audit, and catalog adherence to or deviations from the performance standard. Balancing the sensitivity and utility of the measurement tool requires due diligence in the design process, comprehension of the task and objective, and concurrence with subject-matter expertise (Phillips, Ross, & Shadrick, 2006B). Human interaction factors must be considered in the design and development of the measure along with implementation of the tool. The following sections on cognitive task analysis (CTA) and BARS describe the methodology used to develop performance measures for this thesis research. The subsequent method chapter will provide greater detail regarding these two phases.

1.   Cognitive Task Analysis

Cognitive task analysis (CTA) refers to a group of methods that are extensively used in cognitive systems engineering and naturalistic decision-making applications (Hutchins, Pirolli, & Card, 2004). Klein's (2001) definition of CTA is "methods for capturing expertise and making it accessible for training and system design" (p. 173). Klein delineated the following five steps: (a) identifying sources of expertise, (b) assaying the knowledge, (c) extracting the knowledge, (d) codifying the knowledge, and (e) applying the knowledge. System design goals supported by CTA include human-computer interaction design, developing training, tests, and models to serve as a foundation for developing an expert system, and analysis of a team's activities to support allocation of responsibilities to individual humans and cooperating computer systems. (An extensive treatment of CTA methodology appears in Crandall, Klein, & Hoffman, 2006.)

Different CTA methods are used for different goals (Hoffman, Shadbolt, Burton, & Klein, 1995.) My goal for conducting a CTA was to obtain operational expertise from SMEs on task performance of complex tasks that are trained in the IIT and use this information to develop behaviorally-anchored performance measures. A CTA requiring resource-intense analysis is characterized by complex, ill-structured tasks that are difficult to learn, complex, dynamic, uncertain, and real-time environments as well as multitasking. A CTA is appropriate when the task requires the use of a large and complex conceptual knowledge base, the use of complex goal-action structures dependent on a variety of triggering conditions, or complex perceptual learning or pattern recognition skills. The tasks performed by Marine Corps squads involve all of these characteristics.

The CTA that was planned for this research would employ one of the two methods traditionally used for knowledge elicitation from SMEs. These techniques are the critical decision method (CDM) (Hoffman, Crandall, Shadbolt, 1998) and the knowledge audit (KA) (Militello & Hutton, 1998). The CDM generally asks experts to recall a critical incident and asks them to annotate decision nodes through a constrained timeline and draw out possible alternative vignettes through persistent inquiry. KA is a "set of questions or probes that have been extracted from the literature of expert-novice

differences" (Craig et al., 2012, p. 1027). The KA technique reveals noteworthy items in the subject matter, such as, a macro-level perspective of the events, meaningful signals from the environment, and how an expert would improvise when responding to presented vignettes. The KA provides expeditious data collection and implementation advantages with respect to CDM, but lacks the depth and detail that is required for CTAs not constrained in acute time and resource environments (Fowlkes, Salas, Baker, Cannon-Bowers, & Stout, 2000). The initial plan to conduct a CTA was altered. The ONR sponsor of this Marine Corps work directed our attention to a recent CTA report on IED-defeat (Ross et al, 2012). The research plan was modified with the intent to make use of the information included in the CTA on IED defeat

2. Behaviorally Anchored Rating Scales

Behavioral measures are defined as "performance dimensions and scale values in behavioral terms" (Schwab, Heneman, & DeCotiis, 1975, p. 550). These measures, when compared to qualitative trait measures, provide the evaluator more objective measures to assess the trainees' performance. With measures that are less subjective, the evaluator can maintain the necessary objectivity during performance assessment. Behaviorally-anchored rating scales (BARS) were developed as a means to assess the individual's performance in "multidimensional, behavior-specific terms" (Schwab et al., 1975, p. 550). While the BARS concept is applicable to multiple domains, BARS developed for this thesis research are meant for "scenario-based, training sessions requiring sensemaking and/or decision-making, including […] tactical decision game or decision-making exercise sessions" (Phillips et al., 2006A, p. 1).

In developing BARS, there is a uniform methodology be used for their construction. Subject matter experts provide information regarding gradations of expertise (novice to expert) and efficacy (ineffective to highly effective) of outcome (Schwab et al., 1975). This knowledge elicitation procedure is normally conducted using the CTA method. Results of the CTA are used to develop, identify, classify, and group behavioral attributes according to the event. Once complete, a separate group of domain experts are asked to perform the identical identification, classification, and grouping

procedure with the goal of correlating specific behavior(s) to the events. The results are then compared and analyzed for behavior/event retention purposes. Concurrently, the latter group assigns efficacy ratings (point-scales) with respect to the behavior measures of performance. Typically, the developers agree on an acceptable level of variance in the behavior's MoPs criterion, a statistical analysis is performed on the feedback, and those behaviors/events that are within the variance are retained. Finally, retained behaviors linked to the specific events are then incorporated into a "series of [horizontal] scales (one for each dimension) anchored by the retained incident [event]" (Schwab et al., 1975, p. 551). Further refinement from continued BARS utilization will address practical and time-related constraints and limitations.

IV. METHODOLOGY

This chapter describes two separate, but interrelated phases: the behaviorally-anchored rating scales (BARS) development phase and the infantry immersion trainer (IIT) final data collection phase. BARS were developed for the improvised explosive device (IED) defeat decision-making domain. The BARS development phase focused on the design and development of BARS for use at the IIT on Marine Corps Base Camp Pendleton (MCBCP), CA. Discussion of the BARS development phase also describes observational data collected during IIT research visits to test the initial set of BARS. Additionally, attributes indicative of decision-making proficiency levels were elicited during interviews with subject matter experts (SME). In the IIT final data collection phase, a revised version of a subset of the BARS developed previously was employed for the purpose of assessing the metrics' utility. The research received approval from the Naval Postgraduate School (NPS) institutional review board (IRB).

A. BEHAVIORALLY-ANCHORED RATING SCALES DEVELOPMENT

The maneuver squad leader mastery model (MSLMM) developed for the United States Marine Corps Training and Education Command describes military decision making at the small-unit level and served as the foundation for developing BARS. The MSLMM is based on a model of small-unit leadership that describes the, "the general progression to mastery as a maneuver squad leader, including the progression of decision-making proficiency" (Ross et al., 2012, p. 1). The MSLMM also incorporates the Dreyfus and Dreyfus, "five stages of skill acquisition" model of skill proficiency that views proficiency as progressing from novice to expert (Dreyfus & Dreyfus, 1986, p. 20).

The MSLMM framework is premised on 15 decision-making cognitive competencies and cognitive and relational skills (CARS). These cognitive competencies and CARS were developed from surveys of non-commissioned officers (NCOs) and commissioned officers who had experience with MSL small-unit leadership billets (Ross et al., 2012). Nine MSL performance areas were also synthesized from the NCO and commissioned officer surveys. "These performance areas encapsulate interactions

between the decision-making cognitive competencies and CARS into distinct themes"
(see Ross et al., 2012, p. 3). Tables 2 and 3 list the "tactical skills/tactical thinking," and
"communication" performance areas that were selected for their relevance to the IED-
defeat decision-making domain (Ross et al, 2012). The selected performance areas
described in Tables 2 and 3 provide general descriptions of the five-levels of
competencies. They do not include specific operational training considerations.

Table 2.   MSLMM Tactical Skills/Tactical Thinking Performance Areas (From Ross et al., 2012).

Novice	Advanced Beginner	Competent	Proficient	Expert
Tactical Skills/Tactical Thinking				
Understands and can employ basic tactics with his squad. Can pick up cues in the environment, but has difficulty understanding the meaning of cues and events. Not knowledgeable of how to employ and use all available assets. Has difficulty planning/ considering a situation from start to finish including possible consequences. May make quick and rash decisions.	Has a better understanding of the capabilities of the enemy. Still requires some guidance and expects approval from Higher to make certain decisions. Has a better understanding of the situation/ environment and how to plan and execute a mission. Considers consequences when problem solving but still requires some time to make a decision.	Confident in his decision-making abilities and now works with Higher (instead of just asking for help) to come up with solutions. Higher seeks him for advice. Has a better understanding of how to read environmental cues and events, and what they mean to the mission. Squad tactical skills are sharp and he knows how to employ his available assets.	Planning skills have greatly improved. Mentally simulates possible situations, starts rehearsing and considers 2nd and 3rd order consequences. Has a better sense/ reading of the environment. Can pick up on cues and anomalies in time to change mission. Fully understands the implications of his decision making.	More focused on taking the perspective of the enemy. Makes decisions based on the enemy's projected actions and abilities. Can quickly identify a problem and employ squads to solve it. Visualizes the big picture and considers it when making decisions. Paints a picture for higher and is now pushing information up instead of pulling. Can work with a broad intent.

Table 3.   MSLMM Communication Performance Areas (From Ross et al., 2012).

Novice	Advanced Beginner	Competent	Proficient	Expert
Communication				
Has difficulty gauging the appropriate amount of information to report to Higher. Reports may have too much information or leave out important details. Communicates aggressively with squad by yelling or highlighting the negative (models a Drill Instructor).	Can communicate guidance to squad, but it is word-for-word what the Platoon Commander said. Can convey knowledge to Marines. Is able to speak more efficiently with Senior people.	Begins to adapt communication styles based on individuals. Still requires some guidance from the Platoon Commander, but also pulls information. Talks to Platoon Commander about how to carry out mission. Effectively gets thoughts out across the teams and can explain situations accurately.	Now communicates with Platoon Commander only for big stuff, including assets he needs or situations that have strategic implications. Can paint a picture of the situation that the Marines understand.	Knows how to communicate with Higher and squad effectively. Verbalizes battlefield so others can see. Clearly communicated intentions and plans to squad that they can work with. Feels comfortable communicating with Higher and does it with ease. Encourages cross talk.

BARS developed for this research incorporated components of the MSLMM, information gleaned from a cognitive task analysis (CTA) on IED-defeat techniques (Ross et al, 2012), IIT operational training considerations, and SME-defined decision-making proficiency stratifications. Initially, BARS proficiency levels were designed to reflect the five-stages of the Dreyfus and Dreyfus skill acquisition model (Schwab et al., 1975). However, IED-defeat behaviors for which BARS were being developed did not lend themselves to producing scales with five levels of proficiency. Deriving five levels of proficiency that could be discriminated during the fast-paced scenarios was not practicable. Future references to BARS will be specific to the improvised explosive device (IED) domain and the IED-defeat decision cycles (IE3DC) decision-making model explained next.

1.   IED-Defeat Decision Cycles Model

Table 4 lists the decision-making fundamentals (objectives) in the IED-defeat domain (predict, prevent, detect, avoid, neutralize, and protect). These fundamentals are

incorporated into the IED-defeat decision cycles (IE3DC) model (Ross, Phillips, Moon, Baxter, & Cooper, 2008). "The IED3C Model was produced as a result of this effort [(concept mapping)], in order to provide an overarching view of the IED-defeat task from the perspective of a junior Marine, using the IED-defeat fundamentals terminology already in place as a construct for USMC training" (Ross et al., 2008, p. 47).

Table 4.　　Six Fundamentals of the IE3DC model (From Ross et al., 2008, p. 48).

PREDICT the actions and circumstances of the IED process.
PREVENT IEDs from being emplaced.
DETECT IED-related activities and IEDs before detonation.
AVOID IEDs in order to deny the enemy a target.
NEUTRALIZE by reducing or overcoming IEDs.
PROTECT the force against effects of IEDs.

As shown in Figure 5, the IE3DC model is premised upon a concept map structure (Ross et al., 2008). Concept maps are schematic diagrams representing knowledge and meaning through organized conceptual relationships. Fundamentals of decision making are depicted in the concept map as nodes. Each node propositionally links one fundamental of decision making to another in an IED scenario. The concept map prioritizes higher-ranking fundamentals at the top of the hierarchy (protect and predict) over lower-ranking fundamentals at the bottom of the diagram (avoid and neutralize) (Ross et al., 2008).
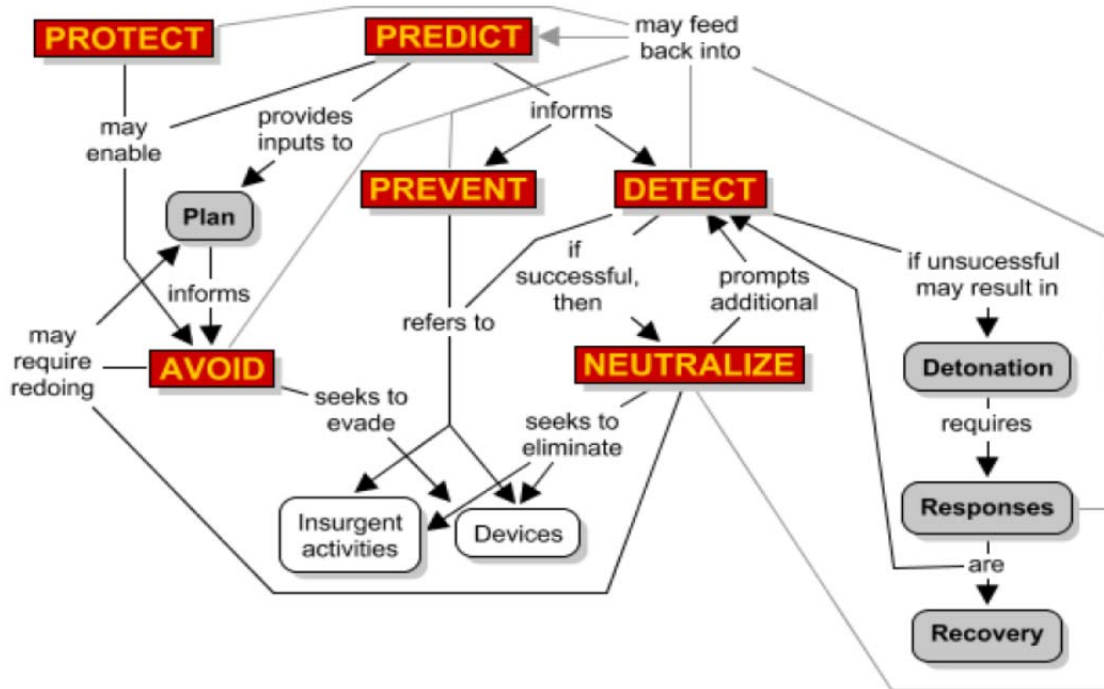
Figure 5.   The Concept Map of IE3DC model (From Ross et al., 2008, p. 49).

In the IE3DC concept map, dependency relationships are depicted as arrows linking individual decision making to "processes related to one activity [having] an impact on another activity" (Ross et al., 2008, p. 49). The nodal fundamentals provide the necessary skeletal composition of the decision-maker's cognitive demands specific to the IED-defeat demands.   Ten cognitive demands were initially selected for their relevance to the dismounted urban environment (see Table 1, in literature review chapter). These cognitive demands were also selected based on the potential to observe decision making associated behaviors without actively engaging with the trainees.

2.   Selected Cognitive Demands

Ten selected cognitive demands that were used to develop the initial set of BARS were drawn from the IED-defeat domain – protect, predict, prevent, detect, avoid, and neutralize as delineated in the MSLMM (Ross et al., 2008). For example, assessing normalcy in the environment is a foundational premise of the predict activity. An individual demonstrating mastery assessing normalcy would demonstrate exemplary

behavior regarding identifying anomalies in the environment (detect), and determine a suitable plan to mitigate the potential adverse impacts on the unit's mission and collective welfare (prevent) (Ross et al., 2008). In response, an expert in this domain would proactively and accurately adjust their tactics, techniques and procedures (TTPs) and activity, and security posture to avoid or marginalize the threat activity. An expert would recognize and comprehend potential second- and third-order effects of their decisions and base their response on the logical course of actions (COAs) from the enemy perspective (neutralize) (Ross et al, 2012).

3. Assessment Factors

a. Verbal and Non-verbal Communication

A military leader communicates verbally and non-verbally in several ways. Examples of verbal and non-verbal communication include issuing orders and using hand signals directed at other unit members, sending radio messages to external agencies (IED reports to higher headquarters), and mission-related interactions with role players (key leader engagements). Communication mechanics and interaction techniques should be assessed by the unit leader's ability to influence the target's receptivity and comprehension of the message (Mueller-Hanson et al., 2007). The format, brevity, and clarity of the information that is transmitted are paramount. Environmental and interpersonal impediments which impact communication include the emotional states of personnel, noise, visual/auditory range, and context. Message comprehension must be evaluated according to the receiver's ability to perceive it, and interpret it. Then the message response needs to be in a rational and proportional manner (Mueller-Hanson et al., 2007). In order to develop observable communication attributes associated with three levels of decision-making proficiency (novice to expert) interviews were conducted with SMEs.

b. Tactical, Technical, and Procedural Execution

Small-unit leaders demonstrate effective leadership by appropriately responding to environmental cues and ensuring actions are aligned with higher echelon's intent (Yeakey, 2002). The small-unit leader's action must not only comply with the constraints provided by their higher echelon (rules of engagement, ethical behavior, etc.),

they must cognitively align with the larger operational schemes and objectives. A Marine squad leader's decision making is based on timeliness and accuracy (Goodson, McGee, & Cashman, 1989). It could be extrapolated that a poor decision made hastily could have the same adverse effects as not making a decision when conditions warrant it. Moreover, the BARS developed for the IIT training environment also assessed procedural compliance to specific safety and standardization formats (Determine How to Establish Security and Cordons (Detonated or non-detonated IEDs)) (Ross et al., 2008).

c. Location and Proximity to the Point of Friction

The first two assessment factors, verbal and non-verbal communication, and TTP execution relate to the small-unit leaders' explicit actions. These two assessment factors do not address the enabling decision of the small-unit leader to position himself within the squad so he can effectively communicate (verbal and non-verbal communication) and tactically maneuver the squad in the environment. Small-unit leaders are expected to: (1) have the basic ability to perceive changes in the environment, (2) know how to effectively communicate with their subordinates as well as the adjacent higher echelon, and (3) know how to employ their resources.

A Marine squad is analogous to a system-of-systems. The unit has thirteen distinct elements who work in three separate, interdependent teams to achieve a coordinated goal. The Marine squad leader is the squad's central decision and execution node through which all inputs and outputs are processed. The fire team leaders act as semi-autonomous responders, feeding stimuli and exercising decisions from the central node. Individual members of the squad act as interfaces, interacting with and manipulating the environment in accordance with the fire team and squad leader's intentions. Execution of the decision process occurs most rapidly and correctly when the fire team leaders and individual squad members are in communication range and proximity to the Marine squad leader.

When the squad encounters a point of friction it impacts the unit's effectiveness. Without central leadership which is inherent in the Marine's squad leader billet, all three separate teams can lose cohesiveness and unity. The Marine squad leader

focuses the fire teams and the individual members of the squad with the commander's intent and purpose. When the Marine squad leader is positioned at the point of friction, his decision execution cycle becomes more efficient because he has first-hand knowledge of the situation. Conversely, the farther away the small-unit leader is from that friction point, the longer it will take to respond accordingly. To interrupt or attempt to influence the squad's decision-making process can paralyze and potentially compromise the orderly function of the squad's mission. For example, in a dismounted patrol there may be circumstances where the fire team elements are visually or geographically separated (separate alley way or road) from the Marine squad leader. The Marine squad leader may have difficulty effectively communicating or conducting squad-level TTPs if the separated elements are simultaneously engaged in kinetics actions. Additionally, the Marine squad leader could be right at the point of friction but encounter something entirely novel and may not know how to respond.

4. Behaviorally Anchored Rating Scales Development

Developing BARS requires a structure that allows modular adjustments to the metric by accounting for the variety of potential scenarios (Phillips et al., 2006A). Initially where refinements and modifications were incorporated, the development process was envisioned to be evolutionary in nature so it would mature. The following are the proposed three BARS versions: post-initial research visit, post-secondary research visit, and post-SME interview. The final BARS would be consistent in format and content with the post-SME interview version.

a. Initial Research Visit to the Infantry Immersion Trainer

An initial visit to the IIT was conducted in order to observe and become informed about the IIT training and operations. The IIT staff provided an operational overview describing the current IIT training, assessment methodology, technology, and training participants. Observations of Marine small-units conducting operational training with semi-structured scenarios were conducted in both indoor and outdoor training ranges. A brief was provided to the IIT staff on this thesis research background and purpose, and addressed how the BARS would provide a more objective and quantifiable

assessment of trainees' proficiency. The majority of the feedback from the IIT staff indicated that any assessment techniques would have to be easy to use and quick to implement. Moreover, any assessment would need to have a negligible impact on the trainer's attention and interactions with the training audience.

IIT operational training is designed and developed around a particular operational scenario and/or set of mission essential tasks. IIT scenario development is typically illustrated through a storyboard. This storyboard format facilitates the IIT staff in organizing the scenario execution and narrative. A storyboard delineates pivotal milestones within the scenario that a Marine small-unit will encounter. As depicted in Figure 6, the information at the top of the scenario storyboard describes the unit (1/7), training day (TD-1), training facility (indoor), scenario number (1), and description (QRF (quick reaction force) to ANSF (Afghan national security forces) IED Find at the Sqd (squad) level). Along the left-hand column tactical objectives, atmospherics, visuals (pyrotechnics), and disposition/composition of the enemy role-players (enemy activity) are described. A graphical depiction of the expected scenario execution is also presented.

Figure 6.   IIT Scenario 1 Storyboard: QRF to ANSF IED Find (From Fennell, 2013B).

The IIT scenario storyboard is an internally distributed planning and operations document. The IIT staff can change the specifics of the scenario prior to and during scenario execution to meet the training requirements of a particular unit. The training staff will only disclose general scenario atmospherics and tactical objective(s) to the training participants. The IIT staff adjusts scenario dynamics and atmospherics as needed to adapt to the squad's level of proficiency and to achieve specific learning objectives.

b. *Behaviorally Anchored Rating Scales Initial Development*

The goal for this phase of the research was to synthesize the existing body of knowledge on BARS development and develop an initial set of BARS. Table 5 lists and describes the ten cognitive demands selected from the IE3DC model, and provides descriptions of IED related behavioral indicators, conditions, and cues.

Table 5.   IE3DC Model Cognitive Demands and Descriptions
(From Ross et al., 2008, pp. 51–56).

Cognitive Demands	Descriptions
1. Assess Normalcy in the Environment	Establishing a baseline understanding of the environment is one of the pillars on which all IED-defeat decisions rest. Knowledge of what is normal – from behaviors of the populace to placement of specific objects in the operating environment – enables detection of change and identification of anomalies that may be indicative of insurgent signatures and devices in the process of emplacement. Normalcy may be passed from unit to unit during Reliefs in Place, from leadership to platoon during battle space preparation, and from Marine to Marine during the course of patrols and convoys.
2. Assess Probable IED Locations	In addition to assessing when IED attacks are likely, Marines continuously assess where attacks may occur. These assessments occur at a general level – i.e., knowing insurgent operation areas and trends in behavior – and at a specific level – i.e., knowing hot spots and evaluating the features of the environment that favor enemy activities. In conjunction with assessing where an IED may be located, another component of this judgment is where particular types of IEDs are likely to be used. For example, high-yield IEDs such as [explosively formed penetrators] EFPs are more typically used on rural routes, while lower-yield IEDs can be anticipated more frequently on urban routes. Marines' assessments of probable IED locations have a direct impact on route planning activities as well as on-the-fly decisions (i.e., during a patrol or convoy) regarding which routes to traverse.
3. Notice Indicators of a Dangerous Situation (Terrain or People)	This decision reflects how skilled Marines detect an IED threat by focusing not just on indicators of a device, but also on indicators throughout the environment that suggest they may be entering a zone where an IED is located. This decision necessarily interacts with those under Predict; Marines use expectations they have about where IEDs might be located and when they are most likely to be emplaced in order to prime their recognition of danger indicators. There are two primary indicators Marines assess when noticing a dangerous situation – terrain, and people and their activities. Terrain features include: cues on the road – e.g., potholes; tread patterns – and cues around the road – e.g., structures such as bridges and abutments. People and activity features include: the extent of current and recent traffic; the absence of civilians and children; and movement in buildings.

4.	Notice Indicators of an IED Device	Another pillar of IED defeat lies in noticing the indicators of a device. This includes noticing components of a device in the context of vehicle and home searches, and identifying IEDs that are emplaced by their component parts. Exhaustion and complacency are common challenges associated with identifying IEDs in the environment. However, when a Marine's attention is focused he can anticipate an IED attack, or when his attention is directed to high-threat areas as a result of his experience, detection becomes more manageable. An extensive list of cues and factors involved in this judgment are provided in the cognitive demand tables (CDTs). As the USMC well knows, these cues and factors are only as current as the improvisations of the enemy.
5.	Assess the Nature and Extent of All Current Threats	This decision concerns the devices as well as other insurgent activities that surround them. Marines must simultaneously judge what they have detected and what threat it poses, and what other threats may be posed by other devices or forms of attack. These judgments consider whether devices may be hoaxes, whether secondary devices may exist, and the possibility of ambush – any of which is possible in any situation. Marines consider information available about the immediate scene, the protective equipment they have in place, their vulnerability, and even the nature of reporting surrounding a device.
6.	Determine How to Trace to the Point of Origin	For devices that suggest a command wire-initiated device, Marines may attempt to trace elements of the device to the Point of Origin, or POO, site. Cues considered are wires and other elements. Tracing is made challenging by the potential for booby traps and secondary devices, and because some POO sites may be great distances from the point of detonation. Marines must judge the risk associated with tracing the wire. When risk is deemed high, Marines may visually attempt to trace a site, and/or walk identifiable paths to the POO site, a strategy that amplifies the challenges.
7.	Identify and Respond to Triggerman (Detonated or non-detonated IEDs)	For devices that require command detonation, Marines look for triggermen. The search may include looking for a line of sight and places that are concealing, and typically goes hand-in-hand with searching for the Point of Origin site. In cases where a triggerman is identified, Marines must then consider how to deal with him. Options here include giving chase, firing, or doing nothing, and each of these options may be considered with regard to safety, feasibility of success, and security.

8.	**Determine How To Establish Security and Cordons (Detonated or non-detonated IEDs**	The goal of this decision is one of safety and of maintaining the integrity of the environment around a detected IED. Marines want to keep everything within the cordon that was there at detection, and keep anything else out. In determining when to establish a cordon, Marines are challenged by the often lengthy duration of time EOD[(explosive ordinance disposal)] may take to arrive on scene. In determining how to establish a cordon, Marines must take into account the terrain around the IED site, manpower, and vehicles at their disposal.
9.	**Consider How to Respond Immediately to Detonation (Detonated IEDs)**	Upon detonation, Marines must make split-second decisions about how to respond. These decisions include whether to approach the detonation site, whether to dismount, and where to place vehicles in a convoy. All of the other Neutralize decisions and judgments above come immediately into play, and are made all the more challenging by the stress of enduring the detonation and deep-seated first impulses to help victims and fight. Platoon leadership must also consider when and how to communicate with higher headquarters. Other post-detonation decisions include assessing the damage, responding to injuries or casualties, and responding to disabled vehicles.

The initial version of the BARS was based on the ten cognitive demands listed and described in Table 1 of the literature review chapter. As depicted in Figure 7, the BARS format consisted of three parts. Each part was annotated by the part number (I, II, and III) in bold red lettering. Part I stated the general scenario description (unexploded IED), and the associated cognitive decision related to the perceptual task (notice indicators of an IED device). In addition to the cognitive decision, part I also specified the perceptual task related to the IED (identify IEDs). Part II is a 5-point scale based on the Dreyfus and Dreyfus skill acquisition model where proficiency ranges from novice to expert (Dreyfus & Dreyfus, 1986). The scales were intended to be used by the assessor to observe the Marine squad leader's behavior, and then mark the proficiency level associated with the cognitive decision in part I, using the related descriptors of observable behaviors annotated in Part III. Part III consisted of multiple behavior factors (listed across the rows), containing five levels of observable cognitive linked behaviors (columns).

The central tenet of the BARS utility was the ability to associate observable behaviors demonstrated by the training participants with objective criterion that differentiated between highly proficient (expert) and novice behavior. In addition a report on CTA was used to develop initial descriptors (Ross et al, 2012). However, observable indicators of the decision-making behavior were not found in the report due to an incompatibility between the scope of the CTA on IED-defeat performance and the IIT-specific training. The existing literature provided information to develop the set of behavioral cues for the BARS. As depicted in Figure 7, the cognitive demand (notice indicators of an IED device) includes observable decision-making behaviors (identifiable cues of IED danger areas, IED assessment techniques, and cultural and environmental IED emplacement knowledge). During the researcher's second visit to the IIT an initial version of BARS were employed to test the BARS utility.

Scenario: Unexploded IED

Decision: <u>Notice Indicators of an IED Device (Identify IEDs)</u>
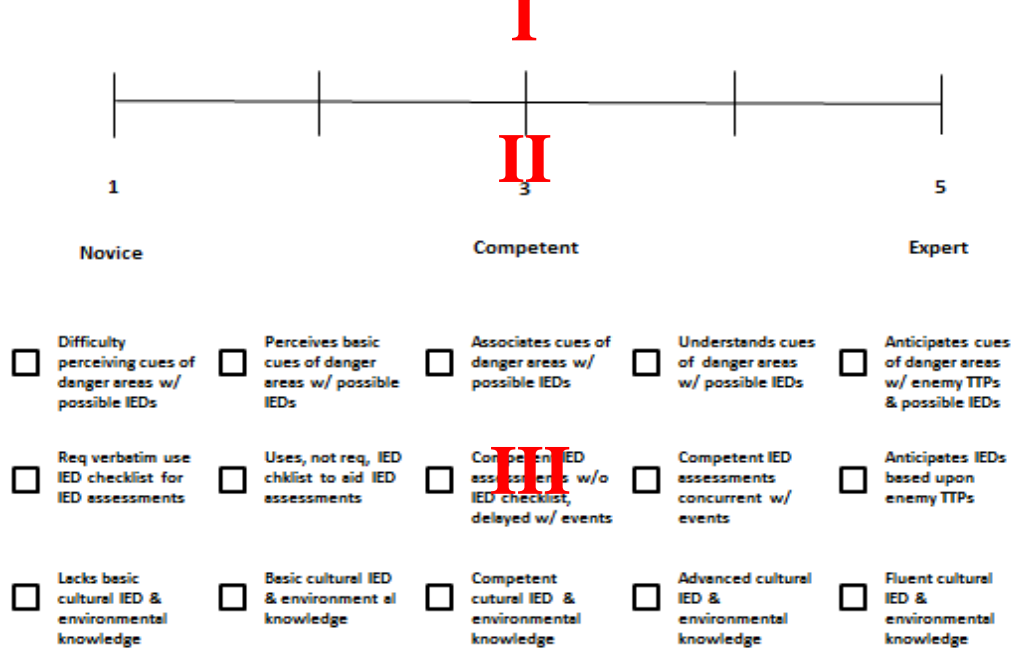
Figure 7.   Example of an Initial Behaviorally-Anchored Rating Scale: Notice Indicators of an IED Device.

c.   *Second Research Visit to Infantry Immersion Trainer*

The purpose of the second visit to the IIT was to further develop the researcher's familiarity regarding IIT operations, training and scenario development, and BARS utilization. The first day focused on familiarization with IIT operations, and scenario development and execution. During the following three training observation days, the focus was on acclimatizing to the IIT training environment and utilization of the metrics already developed. The following list includes the research objectives for the second visit: (1) To achieve a more comprehensive understanding of the IIT staff roles and responsibilities; (2) better understand the IIT training scenario development and execution process; (3) comprehend the limitations and constraints of the IIT staff and facilities; (4) elicit feedback from the IIT staff regarding thesis research and BARS development; and (5) coordinate follow-on final data collection.

The following observations occurred over a four-day period. Each day provided additional insights and lessons learned.

(1) Day One Observations. Upon arrival at the MCBCP IIT, the IIT director and operations officer provided an overview of IIT operations ranging from staffing and training issues, to facilities and contractor support considerations. Additionally, information was provided regarding first Marine Expeditionary Force (I MEF) IIT utilization policy, and ongoing experimentation and assessment projects. In subsequent conversations, video and audio capturing technologies were discussed as a means to facilitate after-action reviews (AARs) and trainer assessments.

Between the first two IIT visits, a change occurred in the manner in which the IIT staff captured and integrated selected scenario video segments into the AAR. The legacy instrumented video/audio capturing system called TVCS (tactical video capture system), had an inherent and significant delay in processing selected videos for the AAR. Given that training scenarios typically required 30-60 minutes to complete, time spent processing TVCS videos for the AAR had become too time-consuming and ineffective as the primary debriefing aid. The IIT staff implemented a change from the instrumented close-circuited TVCS to a hand-held contour camera system employed by individual IIT staff. Usage of handheld cameras reduced the inherent processing delay in the TCVS/Spotlight systems from 20 minutes to 5 minutes. This improvement allowed the IIT staff to increase the number of training scenario runs significantly over a four-day training evolution.

In additional conversations, the IIT operations officer elaborated on their training philosophy regarding scenario development, where he emphasized a winnable, applicable, and coachable approach to training Marines. Each event must afford training participants a modicum of mission success and personal growth. Salient tactical and technical execution points must demonstrate relevance and applicability to preparing the training audience for future operational deployments. Finally, events must emphasize an open-ended decision-making process, that is to say, there is not always one correct way to respond to a given situation. The training environment must be conducive to and provide the impetus for IIT staff guidance and COA training audiences.

An example of the BARS was provided to the IIT operations officer and he was asked to provide feedback regarding the applicability of this metric. His initial feedback focused on the individual units and their respective pre-deployment training program (PTP) cycle. He stated that units further along in their PTP cycle have a distinct and expected advantage regarding TTP proficiency and execution compared to units who are not as far along in their own PTP cycle. Units early in their respective PTP cycles are adversely affected by personnel turnover, unit cohesion, and leadership continuity issues. His opinion was that a trainer who uses BARS would need to consider where the unit is in their PTP when assessing of the unit's performance.

(2) Day Two Observations. Day two consisted of observing squads engaging in scenario runs in the indoor facility. Figure 8 shows the AAR Room which served as the main debriefing location for the indoor scenario runs. A total of six training scenario runs and/or AARs were observed, specifically training day one, indoor scenario one and three.

After querying the unit's Platoon Commander regarding scenario training run information, the Platoon Commander confirmed that the squad was in a QRF role providing assistance to the ANSF for securing the bazaar due to an identified IED threat (training day one, indoor scenario one). With this knowledge, it was decided that the following three BARS would be used: "Notice indicators of an IED device," "Determine how to establish security and cordon," and "Consider how to respond immediately to detonation." The following paragraphs summarize observations and highlights of day two training scenario runs utilizing the BARS.

Figure 8.   Phase I AAR Room (From Thelen, 2013).

(3) Training Day One, Indoor Scenario One.   1st Squad: As depicted in Figure 6, the Marine squad's primary mission objective was to interact with the ANSF at a simulated bazaar and support a cordon and security in the bazaar around an identified IED.   A secondary objective was to support a simulated EOD unit with protection and security.   Figure 9 shows the Marine squad entering the indoor training facility and moving slowly toward the bazaar (objective area).

Figure 9.   Marines navigate through alleyways of the Phase I of IIT
(From Thelen, 2013).

The lead fire team element of the squad was spearheaded by a Marine holding a compact metal detector (CMD). The lead Marine, referred to as the Sweeper, carried and used the CMD to search for high-density objects, such as mines or IEDs in the intended navigable direction and path of the squad's movement. Once the CMD detected a metallic (high-density) object under its sensor, it emitted a visual and auditory indication. As previously discussed, the IIT is a converted former tomato packing plant with some legacy infrastructure artifacts, such as metal rebar throughout the concrete surface of the indoor facility. This particular artifact caused the CMD device to continually emit indications of highly-dense objects. The IIT staff accompanying the respective unit compensated for the metal artifact by providing the Sweeper an audible indication of the correct emanation. A verbal, "soft," "weak," "hard," or "strong," indication was given by the trainer to simulate the level of detection.

As the squad approached and entered the objective area, the Marine squad leader moved forward and interacted with the ANSF unit leader. It appeared that the squad leader was receiving a brief from the ANSF unit leader regarding the bazaar danger area. Additionally, the ANSF unit leader signaled the general proximity of the IED device at 3B (Figure 10). With the general proximity of the IED shown, the Marine squad leader paused a moment and then visually confirmed the ANSF leader's claim. The "Notice indicators of an IED device" BARS (see Figure 7) was utilized at this juncture in the scenario.

The "Notice indicators of an IED device" BARS consists of three factors shown in Figures 10, 11, and 12. These three factors include noticing danger area cues, IED cue detection response performance, and cultural and environmental discrimination of IED emplacement characteristics. The first behavior factor (Figure 6), "Notice IED danger area cues" was assessed, followed by the other two behavior factors in order (Figure 11 and 12). When observing the Marine squad leader's response to the ANSF unit leader's hand-and-arm signals and his subsequent scrutinizing the terrain, it appeared that the Marine squad leader was attempting to perceive and categorize the IED/mine cues from the terrain. After reading the descriptors associated with each point on the BARS scale, the rater determined that the fourth marker, "understands cues that indicate danger areas with IEDs," was an appropriate rating.

In highlight, assessment of the Marine squad leader's behavior related to identifying IED danger area cues was completely subjective in nature. This assessment used length of time spent visually looking into the danger area as a positive indication of a systematic search methodology. Additionally, the assessment assumed the amount of time the Marine squad leader spent surveying the danger area was positively correlated to correctly identifying the IED/mine location. These two assumptions were based on three unsubstantiated biases that influenced the assessment. First, the Marine squad leader was completely receptive to the ANSF unit leader. This was unfounded because there was not the ability to objectively verify the Marine squad leader's confidence in the ANSF unit leader's knowledge. Second, the Marine squad leader had competent expertise to locate and identify the IED/mine threat at 3B (remote control,

command-weight switch, command-wire, etc.). This information about the Marine squad leader was unknowable without retrieving his demographic information. Third, the Marine squad leader comprehended the approximate IEDs/mine's effective casualty radius (ECR). The Marine squad leader's knowledge and awareness of the IED characteristics was also unknowable without demographic information on the Marine squad leader. These assumptions and their underlying biases were not supported or substantiated by other objective evidence.
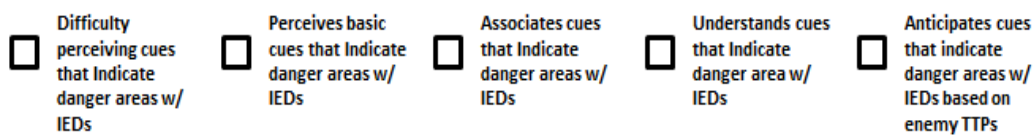
Figure 10.   Behaviorally-Anchored Rating Scale Version One: Notice Indicators of an IED Device (IED Danger Area Cues).

The Marine squad leader's verbal and non-verbal (hand-and-arm signals) interactions with other members in his unit were observed in addition to his interactions with the ANSF unit leader. It is noteworthy that the ability to hear the Marine squad leader's radio communication from the Phase I AAR Room was extremely difficult given the limiting acoustics of the indoor facility, and limited access to the training participant's radios. The indoor closed-circuit television (CCTV) camera perspective and AAR room monitor resolution additionally prevented the rater's ability to visually decipher verbal interactions between the Marines, role-players, and IIT staff during training scenario runs. Communication behavior of the Marine squad leader could only be inferred through observing his non-verbal communication. After observing the Marine squad leader's communicative behavior, it was ascertained that the Marine squad leader's "IED danger area response performance" was consistent with BARS level four "competent real-time identifying of danger areas with IEDs" (Figure 11).

In hindsight, the assessment of this behavior factor had similar pitfalls described in the previous "noticing indicators of an IED device" factor. There was not a distinct means of articulating the timing and/or accuracy of this behavior

factor's performance criteria. Additionally, it was not possible to observe when the Marine squad leader utilized a reference such as a checklist from the Phase I AAR Room. Having distinct and definable response performance criteria codified prior to scenario training run execution would enhance this factor's usability.

| □ Req verbatim use IED checklist to identify danger areas w/ IEDs | □ Uses, not req, IED chklist to identify danger areas w/ IEDs | □ Competent, but delayed w/ identifying danger areas w/ IEDs w/o IED checklist | □ Competent real-time identifying danger areas w/ IEDs | □ Anticipates & locates danger areas w/ IEDs based upon enemy TTPs |
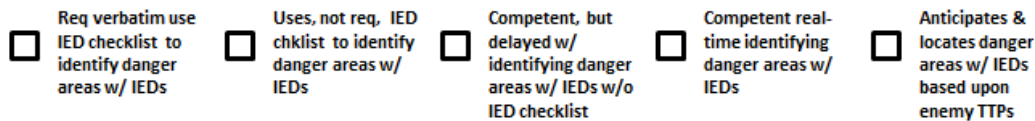
Figure 11.   BARS Version One: Notice Indicators of an IED Device (IED Danger Area Response Performance).

The Marine squad leader was observed surveying the bazaar danger area for potential IEDs. It was inferred that the Marine squad leader was actually searching for physical indicators of IED emplacement. IED emplacement knowledge was critical given that IED emplacement characteristics can change substantially from one geographic region to another. Understanding the geographically specific IED emplacement characteristics of the deployable operational environment provides a greater situational awareness and improves self-protection. Although there are distinct differences in IEDs used in different locations, there are specific IED heuristics shared across these geographic domains. Future reference to IEDs will be specific to ground-borne, stationary devices.

How the IED is actuated provides important information related to the IEDs physical and emplacement characteristics. The IIT trainers and staff provide limited information to the training participants regarding the simulated IEDs effective causality ranges (ECRs) in the IIT training environment. The Marine squad leader's ability to recognize IED emplacement characteristics is important in determining standoff ranges and cordon considerations. When rating the Marine squad leader's IED emplacement knowledge and awareness using the BARS in Figure 12, he was rated a "competent" evaluation because no Marine stepped on or actuated the simulated mine in the scenario.

☐ Lacks basic cultural IED & environmental knowledge & awareness	☐ Basic cultural IED & environment al knowledge & awareness	☐ Competent cutural IED & environmental knowledge & awareness	☐ Advanced cultural IED & environmental knowledge & awareness	☐ Fluent cultural IED & environmental knowledge & awareness

Figure 12.   BARS Version One: Notice Indicators of an IED Device (IED Emplacement Knowledge and Awareness).

As the cordon was quickly established around the bazaar area with the assistance of the ANSF, it appeared that the ANSF were tasked to move the civilians (role-players) out of the bazaar area cordon. The size of the simulated bazaar was distinctly smaller than what is available in the outdoor (Phase II) training range. It appeared that it would now be appropriate to utilize the "determine how to establish security and cordon" BARS. Figure 13 shows this BARS has four behavior factors related to locating the IED. They are as follows: IED location, IED emplacement knowledge and awareness, 5/25 meter searches, and integrity and security of the cordon until EOD arrives. After establishing the cordon at the entrances to the bazaar, the Sweeper was tasked to clear designated locations of the cordon area.

This metric's first two behavior factors were previously discussed in the "notice indicators of an IED device" BARS and assessed at the same proficiency levels. The drawback associated with nesting several distinct and independent factors was a significant lesson learned in the BARS development process. The next behavior factor relating to the 5/25 meter searches of the danger area was done independent of the Marine squad leader's direction. Observing whether the Marine Squad leader individually conducted 5/25 meter searches was impossible from the vantage point of the Phase I AAR Room. The only indication of this behavior's proficiency was the number of potential IEDs discovered and false positives. Since this information was not technically known prior to scenario execution, nor incorporated into the existing metric, this behavior factor was not assessed.

Scenario: Unexploded IED

Decision: <u>Determine How to Establish Security and Cordons</u>

1	3	5
Novice	Competent	Expert

☐ Req verbatim use IED checklist to ID IED Point of Origin (POO)	☐ Uses, not req, IED chklist to ID IED POO	☐ Competent, but delayed to ID IED POO w/o IED checklist	☐ Competent real-time ID IED POO	☐ Anticipates ID of IED POO w/ enemy TTPs
☐ Lacks basic cultural IED & environmental knowledge & awareness	☐ Basic cultural IED & environmental knowledge & awareness	☐ Competent cultural IED & environmental knowledge & awareness	☐ Advanced cultural IED & environmental knowledge & awareness	☐ Fluent cultural IED & environmental knowledge & awareness
☐ Does not initiate Cordon to enable 5/25m searches w/o remediation	☐ Initiates Cordon to enable 5/25m searches but requires guidance	☐ Competently initiates Cordon to enable 5/25m searches but delayed from standard	☐ Competently initiates Cordon to enable 5/25m searches real-time	☐ Fluently intiates Cordon to enable 5/25m searches w/ awareness of enemy TTPs
☐ Req remediation of Cordon is executed in order to secure area until EOD arrives	☐ Basic Cordon is executed to secure area until EOD arrives	☐ Competently executed Cordon area is established and secured until EOD arrives	☐ Advanced execution of Cordon is established to secure area until EOD arrives	☐ Fluent execution of Cordon is executed to secure area until EOD arrives

Figure 13.   BARS Version One: Determine How to Establish Security and Cordons.

The squad's Platoon Commander was also observing the scenario execution from the Phase I AAR Room and was role-playing the simulated combat operations center (COC) (squad's higher headquarters). The COC was not receiving radio communication from the Marine squad leader regarding the identified IED. The Platoon Commander commented aloud that the lack of radio communication in the form of an IED 9-Line report was not normal. This radio communication irregularity was an issue that in hindsight plagued future training scenario runs. The issue was identified and attributed to two factors. The first factor related to an improper radio crypto logic fill, and the second factor related to the internal infrastructure of the Phase I facility. Both issues separately could cause a severe impact to sustaining communication and both factors together would make radio communication nearly impossible.

Radio communication was successfully established after the Platoon Commander installed the proper radio crypto logic fill and adjusted his transmission location and antenna configuration. When the Marine squad leader

successfully communicated the IED 9-line report it was in an incorrect format and the report's contents were not relevant to the IIT scenario. The Marine squad leader did not provide the IIT specific building location and the radio communication cadence was erratic. This issue forced the Platoon Commander to explain over the radio the correct reporting format, creating friction and delay to the unfolding scenario. Additionally, the COC had to direct the Marine squad leader to search and report the status of other potential IEDs in the cordon area. In hindsight, these types of issues occurred repeatedly throughout the training day, and were not mutually exclusive to this squad. Finally, the simulated EOD unit (IIT staff) was brought into the scenario, the EOD disarmed the IED and the scenario came to an end.

The final BARS behavior factor, "integrity and security of the cordon until EOD arrives" was assessed. As depicted in Figure 13, the behaviors included in this behavior factor were the exclusive control of the cordon with respect to avenues of approach, the internal quarantine of IED/mine devices (location, identification, and marking), and finally the EOD link-up plan and execution. The scenario did possess some artificiality with respect to the trainer's compression of the EOD timeline. The amount of time required by the simulated EOD to arrive, get briefed and finally neutralize the known IED was relatively fast (<30 minutes). Conversely, the time required in an operational environment for EOD to arrive after receiving the request, receiving a proper briefing, and then disarm the unexploded ordinance (UXO) would requires substantially more time than what was available in the scenario timeline (indoor scenarios usually last approximately 45 minutes to one hour). This artificial time consideration was not meant to question the relevance of the cordon actions, rather the truncated time line forced the Marine squad leader to ensure his decisions were made in an efficient manner. Observing the EOD/Marine squad leader's interaction over a ten minute period, the rater assessed that he competently executed the behaviors at level three.

With the IED/mine disarmed, the scenario training was complete and the squad moved to the Phase I AAR Room. The trainer began the AAR by explaining the video's perspective shown on the monitor would be from the point of view

58

of a potential adversary or threat. The trainer emphasized that the squad should comprehend the enemy's perspective in dismounted environments. He continued by stating the Marines needed to appreciate their adversaries as active components of the battle space. The trainer subsequently presented video excerpts of the squad as they progressed through the scenario training run. Each pause of the video focused on individual and collective deviations (learning points) related to internal/external communication, roles and responsibilities, TTP conduct and execution, and cordon/security conduct and procedures. The trainer's point was to elicit individual perspectives of the situation, present the actual ground truth of the event, and contrast the training participant's perspectives against the actual transpired events.

Training Day One, Indoor Scenario One—2nd Squad: The second scenario run was significantly different from the first scenario run due to a Marine becoming a casualty as a result of stepping on a simulated pressure-plate mine between A5 and A3 (see Figure 6). Two casualties occurred from the detonation in this scenario, a Marine and an ANSF soldier. Both casualties were dragged into the mock police station compound located at A5. The Marine squad and the ANSF fire team completely collapsed into the A5 compound and surrounding exterior wall.

After observing the post-detonation environment, it appeared appropriate to utilize the "consider how to respond immediately to detonation" metric. As depicted in Figure 14, there were four behavior factors related to this BARS: awareness of personnel location, 5/25 meter searches, establishment and maintaining of a cordon, and reporting considerations to higher headquarters. The transpired events gave the impression that the metrics would be difficult to utilize. Three factors made assessing the Marine Squad leader's behavior using the BARS difficult. First, the affected casualties required immediate medical attention so they were quickly moved from post-detonation into A5 compound without direct involvement of the Marine squad leader. The inability to ascertain the Marine squad leader's verbal commands and queries prevented utilizing the "awareness of personnel location" behavior factor. Second, when the squad collapsed their positions into the A5 compound, it was done in such an expeditious manner, that it prevented observing whether or not the squad conducted a

5/25 meter search for secondary or tertiary IEDs or mines. Third, establishing and sustaining the cordon and security should be a separate and independent BARS. The remaining behavior factor, 'reporting considerations to higher headquarters' was addressed later in the scenario training run.

Scenario: Exploded IED

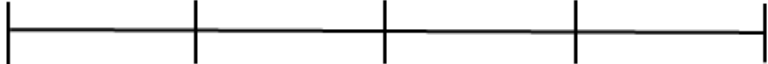**Decision: Consider How to Respond Immediately to Detonation**

1		3		5
Novice		Competent		Expert

☐ Lacks basic awareness and assessment of last known personnel	☐ Basic awareness and assessment of last known personnel	☐ Competent awareness and assessment of last known personnel	☐ Advanced awareness and assessment of last known personnel	☐ Fluent awareness and assessment of last known personnel
☐ Does not initiate Cordon to enable 5/25m searches w/o remediation	☐ Initiates Cordon to enable 5/25m searches but requires guidance	☐ Competently initiates Cordon to enable 5/25m searches but delayed from standard	☐ Competently initiates Cordon to enable 5/25m searches real-time	☐ Fluently intiates Cordon to enable 5/25m searches w/ awareness of enemy TTPs
☐ Req remediation of Cordon is executed in order to secure area until EOD arrives	☐ Basic Cordon is executed to secure area until EOD arrives	☐ Competently executed Cordon area is established and secured until EOD arrives	☐ Advanced execution of Cordon is established to secure area until EOD arrives	☐ Fluent execution of Cordon is executed to secure area until EOD arrives
☐ Does not communicate w/ HHQ w/ in (5) minutes of event and provide first (4) lines of contact report	☐ Communicates w/ HHQ (>5) minutes of event and provide first (4) lines of contact report	☐ Communicates w/ HHQ (<5) minutes of event and provide first (4) lines of contact report	☐ Communicate w/ HHQ (<5) minutes of event and provides contact report & request MEDEVAC	☐ Communicates fluently w/ HHQ(<5) minutes of event and provide contact report, requests MEDEVAC & Enemy EOB

Figure 14.   BARS Version One: Consider how to Respond Immediately to Detonation.

With the Marine and ANSF units moved inside the A5 building compound, it was not possible to hear radio communication from the Platoon Commander's radio in the Phase I AAR Room. It became apparent that the communication issue presented itself again and the Marine squad leader and the Platoon

60

Commander were observed trying to establish 2-way communication. This lack of communication spanned more than five minutes and the delay adversely affected rating the Marine squad leader's performance. With this communication delay, it became apparent the inclusion of a time dimension in any future BARS would not be appropriate given the difficulties in establishing and maintaining two-way radio communication. The BARS for "Consider how to Respond Immediately to Detonation" was deemed ineffective for assessing the Marine squad leader's decision-making performance for this particular cognitive demand.

Once the Platoon Commander (COC) changed his location, 2-way radio communication was established. During the radio transmission from the Marine squad leader, the COC heard the same improper procedural radio format (IED/UXO 9-Line report). This made the Platoon Commander rhetorically comment about there was additional training that was needed regarding proper radio procedures and format. In subsequent two-way radio communication the Marine squad leader demonstrated difficulty in medically classifying the two casualties. After the radio exchange, the Platoon Commander commented again that additional training was necessary in medical classifications and reporting procedures. Finally, the Platoon Commander indicated that there was not a Marine in the Sweeper role after the original Sweeper had become a casualty. The Marine squad leader needed to task another marine to that role. Without a Marine employed in the Sweeper role, the squad had a very remote chance of substantially preventing additional IED/Mine events. The Marines navigated back to the entrance of the Phase I facility, and the scenario training run culminated.

When the squad established itself in the Phase I AAR Room, the trainer began the AAR by covering the events that transpired up to the Sweeper stepping on the mine. The trainer elaborated on the roles and responsibilities of the Sweeper and the Marines around him. IED marking schemes and techniques were addressed, specifically shaving cream or baby powder as suitable means to mark IEDs and cleared areas. Additionally, the trainer elaborated on the squad's lack of explicit and/or vocal lateral communication. The trainer expressed that only through vocal and explicit

communication can their individual intentions and movements build a common situational picture for the other unit members.

Finally, the trainer paused the video where the Sweeper actuates the mine. The video shows the Marine in the Sweeper role visually recognizing the presence of the disturbed earth, but remains silent. The trainer emphatically proclaimed that each Marine had an obligation and responsibility to individually scan the area around them and alert the squad if there were any indications of potential IEDs/mines. The trainer concluded by saying that it was imperative for everyone's survival that when there are confirmed IEDs in the local area everyone should remain vigilant in scanning and ensuring there are not secondary and tertiary devices.

Training Day One, Indoor Scenario One—3rd Squad: Due the length of the previous AAR, observation of this squad's scenario run was impossible. The 3rd Squad had completed their scenario training run while the previous scenario run debrief was taking place. In hindsight, the long occupation of the AAR room not only prevented the observation of this scenario run, but continued long debriefs prevented subsequent observations as well. Moving to another location, such as the Phase I video operator's room located between C2 and C4 (labeled "out of play" on Figure 4) could mitigate this issue.

Interview with IIT Head Trainer

After explaining the purpose and intent of the thesis research, the IITs head trainer was asked to provide an assessment of the research BARS potential utility. He responded that BARS would have to be strictly an enabler to the trainer's assessment. The head trainer also commented that any BARS should not be tied to the promotion or demotion of the unit leader under training. He stressed that units under training have different challenges depending on where they are in their PTP cycle. He explained that it would be unfair to compare a unit's leadership performance against units that are further along in their PTP cycle. Sample BARS were provided for him to review and provide feedback.

(4) Day Three Observations. The previous training day focused exclusively on squad-level scenario runs in the indoor (Phase I) facility. Day three observations focused exclusively on the outdoor (Phase II) training range located adjacent to the Phase I facility. Figure 15 shows the Phase II training range is divided into northern and southern lanes where platoon- and company-level units conduct scenario runs. Phase II observations were exclusively restricted to the TVCS operator's room (Figure 16), located in the IIT administration building (Figure 15).

Figure 15.   Overview of IIT Training Range Infrastructure (From Thelen, 2013).

Figure 16.   Phase II Tactical Video Capture System Operator's Room
(From Thelen, 2013).

During the initial orientation to the TVCS, it became apparent that any observation would have to be more deliberate and focused compared to Phase I observations. The TVCS is comprised of a large-scale CCTV camera network which is remotely-controlled and managed by TVCS operators. The TVCS operator's console and monitor (see Figure 16) was comprised of several cameras vantages of the outdoor training range. Numerous outdoor cameras were selected on the TVCS operator console and monitor and prevented a singular perspective of the scenario run. Interactions with TCVS operators were limited as to not impede their activities and responsibilities. As a result of this constraint, there was limited opportunity to control the camera perspective and scene selection. To mitigate this constraint, the TVCS operators agreed to verbalize the camera perspectives. Additionally, the TVCS operators agreed to discuss where the individual squads or fire teams were located throughout Phase II training ranges. The two observed scenario runs used the same platoon QRF scenario storyboard (see Figure 17).

Enemy Situation: 3-6 man enemy element is engaging an ANSF unit conducting a cordon and search IVO I16 with small arms fire. The ANSF unit is being engaged from the multiple positions to the west, north, and east of the OBJ and have sustained at least (1) friendly casualty.

Mission: Provide QRF support to ANSF unit in a SAF engagement in the northeast corner of the village IOT eliminate all enemy positions and assist them in completing their cordon and search IVO I16.

Atmospherics: Most civilians are taking cover indoors due to firefight.
- A group of civilians are interfering with cordon positions because of civilian injuries sustained in firefight.

Visuals:
- 3 ANSF teams (5 soldiers each) IVO L5, inside I8, and IVO I16 engaged with enemy.
- HME in I16.
- (1) unarmed HME manufacturer in I16.
- (2) Wounded ANSF soldiers on the south side of I16.
- Civilians yelling to ANSF at the OBJ for assistance to treat civilian injuries.
- Injured civilians in H4 courtyard.

Enemy Activity:
(1) Shooter engaging ANSF teams IVO L5 and in I8.
(1) Shooter engaging ANSF team IVO I16 from the 2nd story of K2.
(1) Shooter engaging ANSF team IVO I16 from the L15-L16 courtyard.
(1) Shooter on standby IVO H18.
(1) Shooter on standby IVO F18.
(1) Shooter on standby IVO F1.

3/7 T-DAY 3 Scenario: PLT QRF

Figure 17.   IIT Phase II - Training Day 2, Scenario: Platoon QRF Storyboard (From Fennell, 2013A).

65

Outdoor Scenario Day Three—3/7 Platoon: As the Marine platoon entered the outdoor facility, the platoon split itself into three squad elements. Each element independently entered through different entrances along the northeastern and western entrances of the Phase II north lane (see Figure 17). Additionally, Marine role-players playing adversaries or 'Shooters' were discharging their weapons as a means to simulate atmospherics of the scenario. Civilian and ANSF role-players in the vicinity of K3 compound were observed requesting the platoon's assistance. The three squads were observed navigating toward the ANSF and civilian role-players. As the squads approached the vicinity of the "K" sector of the Northern training range (see Figure 17, bold black letter) they began to receive small-arms fire (SAF) from different Shooters in the K2, L15/16, and H1/H2 buildings. Squads subsequently cleared K2 and L15/16 buildings of Shooters, but the H1/H2 Shooter continued to engage a squad in the vicinity of K3 compound. Finally, the squads subdued the Shooter in the vicinity of H1/H2 buildings, and then all three squads exfiltrated (EXFILL) through the northern exits of the Phase II training range.

During the platoon's engagement in the scenario, there was considerable difficulty using the BARS. The inability to see and/or hear the Marine platoon or squad leader's individual actions and/or radio communications impeded using the BARS. A critical difference between observing scenario runs in Phase I and II was the scale of the two respective facilities, and the ability to focus only on one squad vice three. The scope of indoor facility presented a significant advantage compared to the outdoor facility for the purposes of this research. As a result, the potential exclusion of the outdoor training range for the BARS development was reevaluated at the conclusion of the week's training evolution. Observation of the following platoon's outdoor scenario run reinforced the notion of how difficult rating the Marine squad leader's decision making performance would be in the outdoor training range. Due to the lack of control in manipulating, selecting and focusing the cameras' point of view and display on the TVCS monitor and console, inclusion of the outdoor facility for this research was deemed not suitable.

d.   *Lessons Learned from Second Visit to IIT*

Lessons learned from the second IIT visit, proved invaluable to improving the scope, format, and content of the subsequent version of the BARS. Ten BARS proved to be too cumbersome to use in a 30–40 minute fast-paced scenario. The intent of future data collection opportunities would be to decrease the number of BARS used. Additionally, a modification of the format and content of the BARS metric with respect to Part I, II and III was necessary.

As depicted in Figure 18, the BARS Part I was made more explicit with respect to the cognitive demand (in accordance with the MSLMM). Additionally, the Part I observable decisions were tailored to a specific location within the scenario training run (see Figure 19). The decision to choose a single scenario run rather than multiple scenario runs was due to time and utilization considerations (All squads would use training day one, indoor scenario one). In Part II, the number of proficiency levels was reduced from five to three to provide more concrete descriptors of behaviors for the rating scale. To reduce ambiguity between proficiency levels, explicit definitions and descriptions needed to be placed below each proficiency level. In Part III, each BARS behavior factor was changed to focus on one indicator that would elicit a behavioral response. For example in Figure 18, the IED emplacement indicator in Part III is an ant trail. The associated response by the Marine squad leader to the IED emplacement indicator provided an improved characterization of the Marine squad leader's perception and decision-making skill. SME interviews elicited observable behavior factors that indicated the decision-making proficiency of expert, competent, and novice decision-makers.

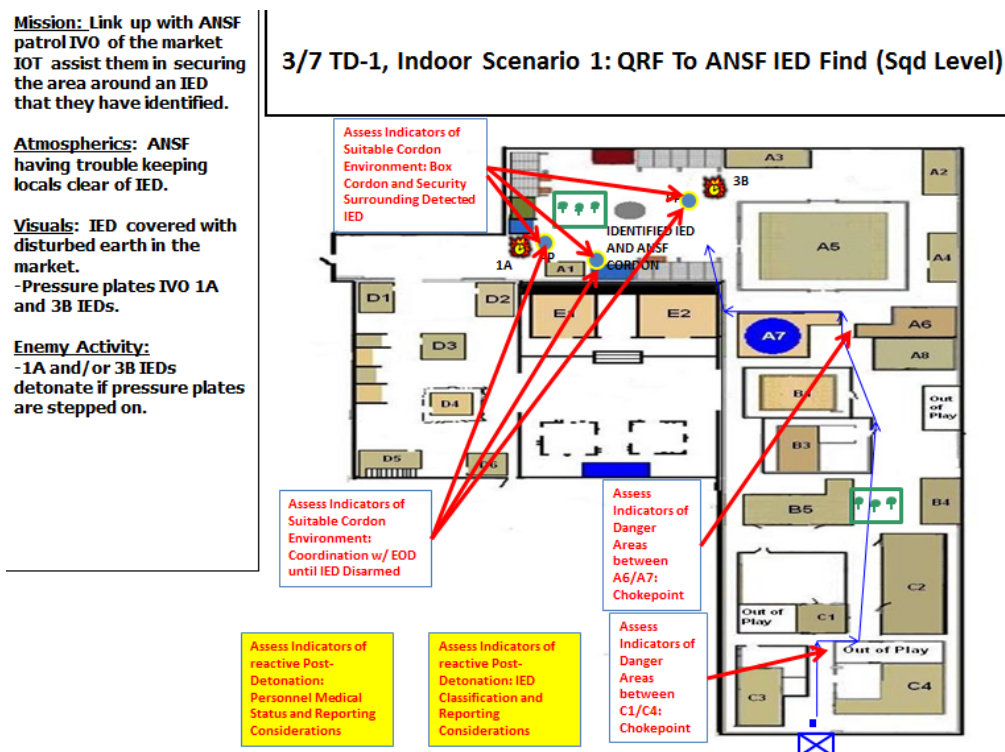Figure 18.   BARS Version 2 – Assess Primary IED Emplacement Indicator @ 3B.

Figure 19.   QRF To ANSF IED Find with Final IIT Data Collection BARS Assessment Locations (After Fennell, 2013B).

5.   Subject Matter Expert Interviews

SME interviews were crucial to the development of the IIT decision-making performance metrics. The purpose of the interviews was to elicit indicators of decision-making behavior linked to BARS stratification levels (novice, competent, and expert). The format of the interview script afforded a conversational approach with the SMEs. The interview's two-way dialog allowed the SMEs to be actively engaged in both direction and depth of the topics presented

Each interview session was expected to take approximately two hours to complete. Development of the metrics required multiple salient perspectives to define the descriptors included in the BARS. Analysis of the interviews provided the necessary descriptors of an expert (high proficiency), competent (standard proficiency), and novice (rudimentary proficiency) decision-makers.

a.   *Participants*

Developing behavioral descriptors for the decisions included in BARS required relevant subject-matter expertise in the task domain. Collecting this information via structured personnel interviews was used to elicit the SMEs knowledge about observable behaviors related to an IED-defeat task.

Participants in this research were to be active-duty NCOs, staff non-commissioned officers (SNCOs), or commissioned officers with relevant ground combat arms experience. Uniformed service members with backgrounds or billets in quick reaction forces (QRF), special operating forces (SOF), or as infantry instructors (Coyotes) were also included.   Additionally, SMEs must have deployed to an expeditionary environment where they were entitled to imminent danger pay within the last forty-eight months.

b.   *Equipment*

Interviews were audio recorded at the approval of the participants to assist the investigators with their data collection and analysis. All information pertaining to personally identifiable information was secured in a manner consistent with the IRB protocol.

6. Post-subject Matter Expert Interviews Behaviorally–Anchored Rating Scales Development

Six SME interviews were conducted over a two-week period. These interviews provided the attributes necessary to discriminate between each level i.e., novice, competent, and expert decision-making proficiency. Participants were provided the training scenario (see Figure 6), and their roles and responsibilities for the interview were explained. In Part III of Figure 20, observable behaviors were synthesized from the SME interview data collection. The number of BARS was reduced from thirty-nine to six post-SME interviews BARS. These six BARS were used in the IIT final data collection phase.

Decision: <u>Assess Indicators of Danger Areas Between C1/C4</u>

	0	1	2
	Novice	Competent	Expert
	- Ineffective application	- Effective Application	- Highly effective application

Danger Area Indicator:

Chokepoint

-No Change in Formation	-Hesitates Change Formation	-Fluid Formation Change
-Doesn't Indiv/FT Bound & Post Security	-Lacks Dispersion	-Proper Indiv/FT Bound & Satellite
-Demonstrates Lack of Tactical Movement	-Constant Tactical Movement speed	-Adjusts Tactical Movement Speed effectively

Decision: <u>Assess Indicators of Danger Areas Between A6/A7</u>

	0	1	2
	Novice	Competent	Expert
	- Ineffective application	- Effective Application	- Highly effective application

Danger Area Indicator:

Chokepoint

-No Change in Formation	-Hesitates Change Formation	-Fluid Formation Change
-Doesn't Indiv/FT Bound & Post Security	-Lacks Dispersion	-Proper Indiv/FT Bound & Satellite
-Walks or Strolls through	-No Adjustment in Pace	-Slow Movement Through DA

Figure 20.   BARS Version 3 – Assess Indicator of Danger Area between C1/C4 and A6/A7.

B. IIT FINAL DATA COLLECTION PHASE

The IIT final data collection occurred during the first two of the four-day training program. All observations and assessments focused on training-day one, indoor (Phase I) scenario one training storyboard (see Figure 19). During this scenario, six behaviorally-anchored rating scales (BARS) were linked to six observational indoor (Phase I) locations. The following measures section elaborates on the specific BARS used for data collection in this scenario. The metrics were printed and laminated on 8.5" x 11" paper. All observations and assessments were conducted in either the MILESTONE operator's room (located in the IIT administration building) or the Phase I AAR Room. Prior coordination with the IIT Operations Officer assured that the same name scenario run would be utilized by all of the training participant's squad elements. Observations and assessments were conducted in a manner to minimize participants' awareness of the researcher. The anticipated number of scenario runs to be observed ranged from four to eight.

1. Participants

The research participants in this phase are from, 3rd Marines, 7th Regiment based out of Marine Corps Base 29 Palms. There are approximately 120 to 180 Marines including support personnel in a Marine infantry company. The company has three infantry line platoons (nine squads) and a supporting weapons platoon. Observations were focused on the nine to twelve Marine squad leaders of the company.

2. Equipment

The observations and ratings occurred in one of two locations, the Phase I AAR Room or the MILESTONE Operator's room. MILESTONE system is an improved instrumented video-capturing system replacing the existing Video Flashlight/TVCS systems used in the Phase I and II respectively. Currently, the Phase I facility is the only training range in the Marine Corps that uses the MILESTONE system. The MILESTONE Operator's room is located in the IIT administration building (see Figure 15).

3.   Measures

Six BARS were utilized in this phase.   Figure 19 depicted the approximate location where the observations were focused occurred.   The BARS results and discussion are described in the following results chapter of this thesis.

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V. RESULTS

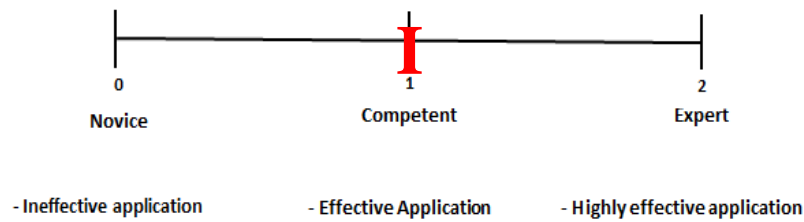This chapter presents results from the infantry immersion trainer (IIT) final data collection phase.

A. MEASURES

The first four BARS mentioned below were considered location-specific and are depicted in white text boxes in the Figure 19. Additionally, the final two BARS mentioned below were considered event specific and are represented by yellow text boxes in the storyboard. Location-specific BARS were pertinent only to specific areas or locations in the scenario, whereas event-specific BARS were only applicable when simulated improvised explosive devices (IEDs) were detonated in the scenario.

As the squad navigated from the southern entrance of the indoor (Phase I) facility they encountered a chokepoint danger area between the C1 and C4 buildings. This chokepoint was the first major decision point encountered by the Marine squad leader. The chokepoint forced the Marine squad leader to recognize and tactically respond to the characteristics presented in the danger area, such as the channelizing features of the L-shaped alleyway, blind corners where visibility is obstructed, and the perpendicular alleyway between C1 and C3 buildings (see Figure 19).

The Marine squad leader used his communication, location and proximity, and techniques, tactics and procedure (TTP) execution to tactically maneuver the squad through the C1/C4 chokepoint. Novice, competent, or expert proficiency ratings were attributed to the associated level of proficiency descriptors listed in Part I (red bold font) of Figure 21. As the squad encountered this first designated rating location, the rater used the descriptors under the rating scale in Part III (red bold font) to determine the Marine squad leader's proficiency level regarding the following decision-making behaviors: change in formation, dispersion through the danger area, and tactical movement speed. The rater then associated the decision making behavior with the decision making proficiency level reflected by the behavior.

Decision: Assess Indicators of Danger Areas Between C1/C4

0	1	2
Novice	Competent	Expert
- Ineffective application	- Effective Application	- Highly effective application

Danger Area Indicator:
Chokepoint

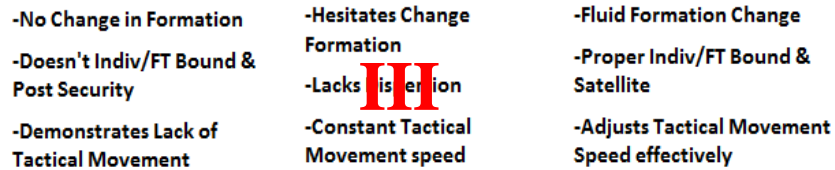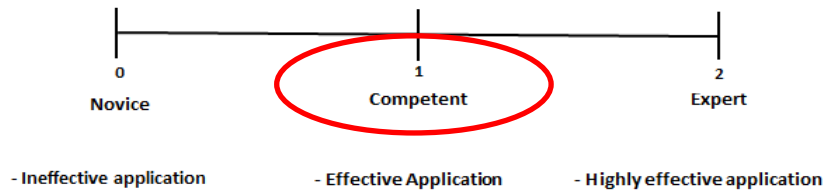|		
-No Change in Formation	-Hesitates Change Formation	-Fluid Formation Change
-Doesn't Indiv/FT Bound & Post Security	-Lacks Dispersion	-Proper Indiv/FT Bound & Satellite
-Demonstrates Lack of Tactical Movement	-Constant Tactical Movement speed	-Adjusts Tactical Movement Speed effectively

Figure 21.   Final BARS: Assess Indicators of Danger Areas Between C1/C4 – Chokepoint.

Once the decision making behaviors were assessed, they were rated, marked and then averaged. When a Marine squad leader had a majority of ratings (Part III in Figure 21) linked to a particular proficiency level, i.e., 0, 1, or 2 (Part I of Figure 21), that proficiency category is awarded (novice, competent, expert). If there were equal distributions of observed behaviors for the proficiency levels, the lesser rating will be awarded. As shown in Figure 22, there was one novice and one competent rating given, and the third behavior was inconclusive or not observable. Since the cumulative average ((0+1) / 2 = .5) were less than competent rating (<1), a novice rating were awarded. However, if three proficiency descriptors were represented equally across the novice, competent and expert categories, the competent rating would be awarded. For example, in Figure 23, there was one novice, one competent, and one expert rating indicated by the red circles. The average scoring of the three ratings ((0 + 1 + 2) / 3 = 1) means that the Marine squad leader was rated a competent decision-making proficiency category for that task.

Decision: Assess Indicators of Danger Areas Between C1/C4


```
          0                    1                    2
        Novice             Competent             Expert
```

- Ineffective application   - Effective Application   - Highly effective application

Danger Area Indicator:
Chokepoint

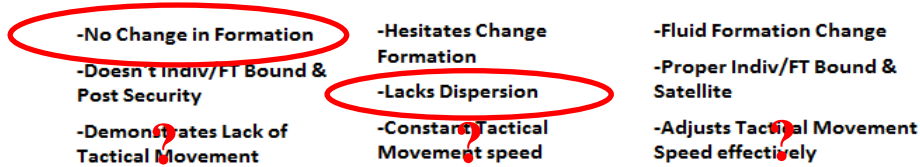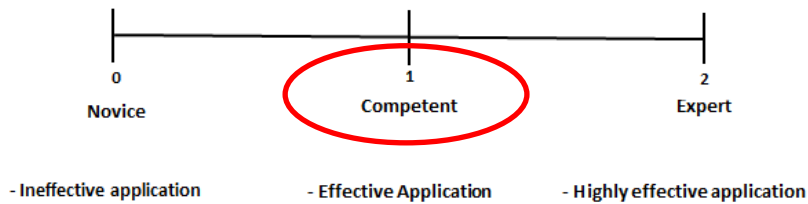|		
-No Change in Formation	-Hesitates Change Formation	-Fluid Formation Change
-Doesn't Indiv/FT Bound & Post Security	-Lacks Dispersion	-Proper Indiv/FT Bound & Satellite
-Demonstrates Lack of Tactical Movement	-Constant Tactical Movement speed	-Adjusts Tactical Movement Speed effectively

Figure 22.   Final BARS: Assessment scoring of the Indicators of Danger Areas between C1/C4 – Chokepoint.

Decision: Assess Indicators of Danger Areas Between C1/C4


```
          0                    1                    2
        Novice             Competent             Expert
```

- Ineffective application   - Effective Application   - Highly effective application

Danger Area Indicator:
Chokepoint

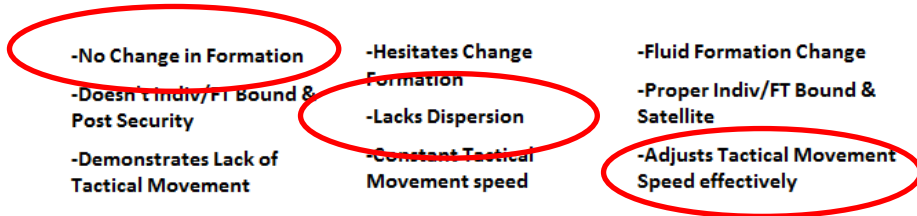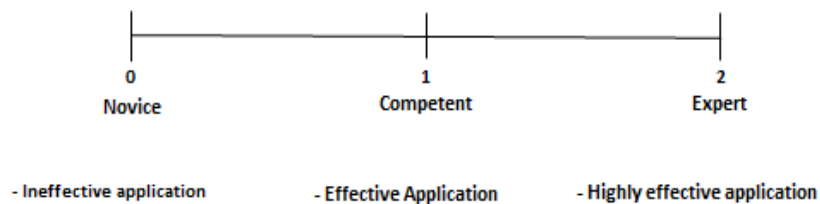|		
-No Change in Formation	-Hesitates Change Formation	-Fluid Formation Change
-Doesn't Indiv/FT Bound & Post Security	-Lacks Dispersion	-Proper Indiv/FT Bound & Satellite
-Demonstrates Lack of Tactical Movement	-Constant Tactical Movement speed	-Adjusts Tactical Movement Speed effectively

Figure 23.   Final BARS: Assessment scoring of the Indicators of Danger Areas between C1/C4 – Chokepoint.

As the squad navigated from the C1/C4 chokepoint toward the bazaar, they likely maneuvered through the chokepoint between the A6 and A7 buildings (See Figure 19). The Marine squad leader either navigated the squad through the A6/A7chokepoint or decided to use an alternate path. Instead of navigating through the A6/A7 chokepoint, the Marine squad leader may instead satellite his individual fire teams. Satelliting is a tactical procedure where the Marine squad leader breaks up the squad into autonomous fire team elements. The BARS shown in Figure 5 assumes that the Marine squad leader and some portion of the squad navigated through the A6/A7 chokepoint.

As shown in Figure 24, the A6/A7 and C1/C4 chokepoints have identical descriptors and were rated in a similar manner. The differences between the two chokepoints were their physical characteristics and proximity to the bazaar objective area. The C1/C4 chokepoint was a more straight-forward danger area compared to the complex characteristics of the A6/A7 chokepoint ("L" shaped vs. "T" shaped chokepoints). A danger area such as the C1/C4 chokepoint allows the Marines to break-up the location into sequential parts. Conversely in the A6/A7 chokepoint, the Marines have to contend with two potential avenues of approach represented by the top of the "T" shape. Finally, the proximity of the bazaar to the A6/A7 chokepoint creates a natural draw and friction point for the Marine squad leader and his squad.

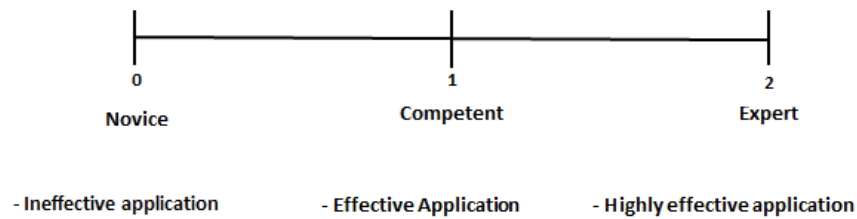**Decision: <u>Assess Indicators of Danger Areas Between A6/A7</u>**

```
|——————————————————|——————————————————|
0                  1                  2
Novice             Competent          Expert
```

- Ineffective application   - Effective Application   - Highly effective application

Danger Area Indicator:
Chokepoint

-No Change in Formation	-Hesitates Change Formation	-Fluid Formation Change
-Doesn't Indiv/FT Bound & Post Security	-Lacks Dispersion	-Proper Indiv/FT Bound & Satellite
-Walks or Strolls through	-No Adjustment in Pace	-Slow Movement through DA

Figure 24.   Final BARS: Assess Indicators of Danger Areas between A6/A7 –
Chokepoint.

The squad's mission in this scenario was to tactically navigate to the bazaar, link-up with the Afghan national security forces (ANSF) located there, identify the point of origin of any suspected IED(s), establish a cordon and security around the device(s), and coordinate with explosive ordinance disposal (EOD) to disarm the IED(s). The BARS focused on the Marine squad leader's decision making in controlling and securing the internal and outer area of the cordon. As depicted in Figure 25, the objective of the BARS was to rate the Marine squad leader's observable decisions related to securing avenues of approach (AOAs), the IED marking plan, fire team security execution, and leveraging the ANSF.

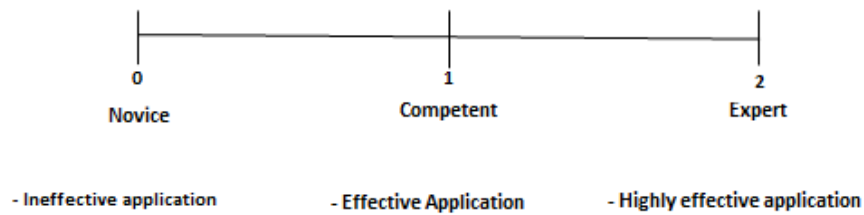## Decision: <u>Assess Indicators of Suitable Cordon Environment</u>

```
├─────────────────────┼─────────────────────┤
0                     1                     2
Novice             Competent              Expert
```

- Ineffective application   - Effective Application   - Highly effective application

Suitable Cordon Environment Indicator:
Box Cordon and Security Surrounding Detected IED

-No Cordon of AOAs	-Partial Cordon of AOAs	-Full Cordon of AOAs
-No Marking Plan	-Marking Plan Ineffective	-Marking Plan Effective
-Positions individuals w/o FT Ldrs	-Sqd Ldrs Coordinates FT Sectors	-FTs Execute Security Automatically
-No Leverage of ANSF/Terp	-Partial Leverage of ANSF/Terp	-Effective Leverage of ANSF/Terp

Figure 25.   Final BARS: Assess Indicators of Suitable Cordon Environment: Box Cordon and Security Surrounding Detected IED.

As depicted in Figure 26, the focus of the BARS was the Marine squad leader's decision making ability to coordinate with EOD to disarm the cordon's simulated IED(s). The BARS decision-making descriptors included the EOD link-up plan, IED marking plan, civilian's location and proximity to the cordon, and employment of the squad's mine sweeping equipment.

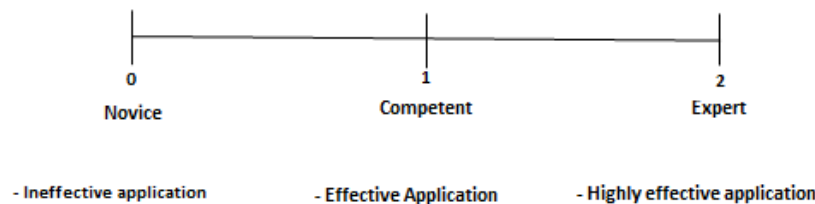**Decision: <u>Assess Indicators of Suitable Cordon Environment</u>**

Figure 26.   Final BARS: Assess Indicators of Suitable Cordon Environment: Coordination with EOD until IED disarmed.

The following two BARS were event specific, rather than location specific in the scenario.   Event-specific BARS were concerned with the simulated unexploded ordinance (UXO), related to the scenario IEDs and mines. Detonations of the simulated UXOs were at the prerogative of the accompanying trainer. With that responsibility, the trainer determined the simulated UXOs effective casualty range and its blast-related effects.   When a detonation occurred, the Marine squad leader had two immediate decisions. First, he must secure the local area in order to mitigate and prevent subsequent engagements. These UXO detonations have operated in combination with other types of attacks such as small arms fire, or secondary IEDs and mines. These combination attacks are intended to create as many casualties as possible.

As depicted in Figure 27, the Marine squad leader's second decision related to the inquiry of the squad's medical status, timeliness of medical evacuation/ casualty evacuation (MEDIVAC/CASEVAC) 9-Line report, MEDIVAC/CASEVAC reporting

fluency, and radio conduct relating to tone, cadence, clarity, and brevity. The UXO/IED 9-Line report to higher headquarters must always be completed after an UXO detonation.

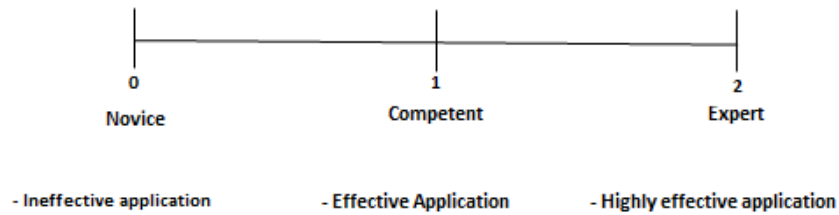**Decision: <u>Assess Indicators of Reactive Post-Detonation</u>**

0	1	2
Novice	Competent	Expert
- Ineffective application	- Effective Application	- Highly effective application

Reactive Post-Detonation Indicator:
Personnel Medical Status & Reporting Considerations

-Doesn't Give CASEVAC Report	-CASEVAC Report Delayed	-CASEVAC Report is Timely
-Delayed Inquiring Medical Status	-Medical Status hesitant	-Immediately Request Medical Status
-Report doesn't match format	-Report Given w/ Reference	-CASEVAC Report is Memorized
-Vague, Erratic, Unclear Communication	-Adequate Communication is Rushed	-Calm, Cool, Collected Communication

Figure 27.   Final BARS: Assess Indicators of Reactive Post-Detonation: Personnel Medical Status & Reporting Considerations.

After simulated UXO detonations, Marine squad leaders were expected to send two radio reports higher headquarters. Their first priority was the CASEVAC/MEDIVAC 9-Line report (assuming there were casualties), followed by the IED/UXO 9-Line report. Both standardized reports were to be sent independent of one another. As depicted in Figure 28, this BARS was used to rate the four behavioral descriptors of the Marine squad leader. The behavioral descriptors related to the timeliness of the IED/UXO 9-Line report, the completeness of the IED/UXO 9-Line report (including remarks), IED/UXO 9-Line reporting fluency, and radio conduct with respect to tone, cadence, clarity, and brevity.

Decision: Assess Indicators of Reactive Post-Detonation

0	1	2
Novice	Competent	Expert

- Ineffective application   - Effective Application   - Highly effective application

Reactive Post-Detonation Indicator:
IED Classification and Reporting Considerations

-Doesn't Give IED Report	-IED Report w/ Reference	-IED Report is Timely
-IED Report Req's Major Clarification	-IED Report Req's Minor Clarification	-IED Report Req's No Clarification
-Report Doesn't match format	-Reporting Convention w/ Remarks	-IED Report is Memorized
-Vague, Erratic, Unclear Communication	-Adequate Communication is Rushed	-Calm, Cool, Collected Communication

Figure 28.   Final BARS: Improvised Explosive Device Classification and Reporting Considerations.

B.   RESULTS

Table 6 presents the results of evaluations of four Marine squad leaders during training day one and two. A total of six scenario run observations were made during the week. However, two of the observations were excluded from analysis due to major modifications that were made to the scenario. These modifications included an ad hoc inclusion of small-arms fire (SAF) engagements, changing the objective area and IED locations. As depicted in Table 6, the remaining four assessments are listed along the top of the table. The BARS titles are listed along the left-hand side of the table. The assessment score for each Marine squad leader was indicated by a numerical "0" (novice), "1" (competent), or "2" (expert).

Table 6.   Number of BARS Assessments.

BARS: Indicator	Unit			
	1st Sqd	2nd Sqd	1st Sqd	2nd Sqd
Assess indicators of danger areas between C1/C4: Chokepoint	0	2	2	2
Assess indicators of danger areas between A6/A7: Chokepoint	1	N/A	2	N/A
Assess indicators of suitable cordon environment: Box cordon and security surrounding detected IED	0	0	2	0
Assess indicators of suitable cordon environment: Coordination with EOD until IED disarmed	1	0	2	1
Assess indicators of reactive post-detonation: Personnel medical status & reporting considerations	No IED Detonation	2	No IED Detonation	0
Assess indicators of reactive post-detonation: IED classification and reporting considerations	No IED Detonation	2	No IED Detonation	0

An additional post hoc assessment of each squads BARS was conducted by the individual IIT trainer who accompanied each squad. Each of the four scenario runs was accompanied by a different trainer; this provided an independent evaluation of each squad leader's BARS scores. Each trainer was asked to compare their evaluation of the squad leader's performance with the BARS assessment and then asked to confirm or disagree with the results indicated by each BARS. Results indicate that the IIT trainers generally agreed with the individual BARS or did not contradict the individual metric's as presented.

C.   DISCUSSION

The goal of this thesis was to develop, refine and employ infantry domain relevant BARS in order to examine their utility for evaluating Marine squad leaders' decision-making performance. During the final data collection phase, six BARS were used for rating the decision making performance of four Marine squad leaders. All observations were based on one training scenario. Only two of the four scenario training runs involved a reactive detonation of a simulated IED. This meant that the "Assess indicators of

reactive post-detonation: Personnel medical status & reporting considerations" and "Assess indicators of reactive post-detonation: IED classification and reporting considerations" BARS were not used for scenario runs that did not have a reactive detonation. Additionally, in two of the scenario runs, the Marine squad leader elected not to navigate through the A6/A7 chokepoint. If it was observed that the Marine squad leader did not personally survey or encounter the chokepoint, the "Assess indicators of danger areas between A6/A7: Chokepoint" metric was not employed.

The limitations of the analysis presented above not notwithstanding, results support the utility of BARS as a practical method for the assessment of Marine squad leaders' decision-making performance. The findings presented here are particularly encouraging in that they demonstrate the realistic possibility of replacing the nonstandard and subjective methods currently employed in LVC infantry training environments such as the IIT. By providing instructors and evaluators the ability to use standardized metrics such as BARS for small-unit decision-making training scenarios, the opportunity for standardizing after action reviews can improve trainee feedback and remediation.

BARS assessment results were corroborated by the IIT trainer who accompanied each squad. Each of the four scenario runs was accompanied by a different trainer. Each trainer was independently shown the Marine squad leader's assessment scores (six) and was asked to confirm or disagree with the metrics' findings. All the IIT trainers generally agreed with or did not contradict the individual metric's findings.

1. Lessons Learned from Thesis Research

There were several lessons learned from this thesis research and are discussed in the following:

- There exists little consensus in the BARS literature on the metric's format and structure. Additionally, there was a lack of empirical applications of BARS. Further, reference in the literature to assist in developing BARS for applied domains is sparse.

- An emphasis on prior coordination is essential when conducting field research at an operational training range. Limited knowledge of IIT scenarios and

operations hampered assessments and ratings during the second IIT visit. During the third visit to the IIT, limited awareness of the scenario run scheduling and order inhibited set up and preparation for each event. The researcher had to constantly request status updates and confirmations from the IIT staff regarding scenario run times and squad identification.

- Ad hoc changes by the IIT staff during the third visit, prevented inclusion of two of the six scenario run observations. There was little warning of the changes prior to their introduction into the scenario run. Since training participant leadership drove the training objectives, the IIT staff made modifications on the fly to reflect their intent or wishes. The two excluded scenario runs included modifications early into the scenario runs. The changes adversely affected the researcher's ability rate the Marine squad leader and made using the BARS irrelevant.

- During the BARS development, there was a consistent trial-and-error theme to the BARS. During the second visit to the IIT, it was discovered that some BARS that were supposed to be independent were actually nested into the behavioral descriptors of other BARS. For example, in the "Consider how to Respond Immediately to Detonation" BARS (Figure 14), the fourth behavior factor focused on assessing the establishment of a cordon around an IED. As previously mentioned, the "Determine How to Establish Security and Cordons" BARS (Figure 13) is an independent BARS and cognitive task.

- Due to the restrictions incorporated in the institutional review board (IRB) research protocol, personal observations of the squads engaged in training was not permitted for data collection. All observations and ratings occurred while watching video monitors of the squads engaged in training. Having the prior agreements and coordination with the training participants and the NPS IRB would have greatly improved the quality of the results.

VI. RECOMMENDATIONS AND FUTURE WORK

This thesis research demonstrated a deliberate approach toward developing behaviorally-anchored rating scale (BARS) assessments. Behavioral responses assessed were specific to Marine small-unit decision making. The introduction, background, and literature review chapters described the motivation and scope of the metric development process. The methodology and results chapters encompassed the empirical application of the method. The following sections elaborate on the BARS development and future work recommendations.

A. BEHAVIORALLY-ANCHORED RATING SCALES DEVELOPMENT RECOMMENDATIONS

This section presents recommendations from the BARS development process. Several impediments were encountered during the BARS development process which impacted bringing this assessment method to reality. The following recommendations are based on the researcher's experience during the BARS development process.

- **Research is more than finding the answer** – The goal of research should not be exclusively focused on the end state of the results. More often, scientific insight is garnered from application of the scientific process that can empirically fail or go awry. The scientific method is predicated on the replicative process, rather than the process's product. One goal of this research was to ensure the process is repeatable in order to sustain research findings. In other words, the answer is less important than the information discovered from the analysis. In this BARS development process, there was an initial preoccupation with trying to make the BARS relevant to all training scenarios. The more appropriate approach was to make a single metric applicable to a specific scenario and determine its relevance. Occam's razor exemplifies this concept with "all other things being equal, the simpler explanation is preferable" (Blumer, Ehrenfeucht, Haussler, & Warmuth, 1987, p. 377). Scoping the BARS to a single training scenario was a more effective approach to rate decision-making for this thesis.

- **Making lemonade when the world gives you lemons** – Thesis research was not dissimilar to combat, in that "no plan of operations extends with certainty beyond the first contact with the main hostile force" (Vego, 2007, p. IX-63). Reviewing research literature and incorporating guidance from thesis advisors assisted the thesis acclimatization process to a point. Beyond planning, this

thesis research required a creative and adaptable plan capable of contending with several expected research difficulties.

- During the BARS development process, issues arose during the analysis of subject-matter expert (SME) interview data. These issues were related to contradictions in SME responses such as, when SMEs independently refuted other SME assertions. Differences in data collected to develop decision-making attributes produced indecision about which SME responses were more valid or accurate. Compounding this dilemma were additional constraints related to limited personal or professional experience in the domain (that is, the researcher was a Marine aviator, not a Marine infantry officer). Without an objective reference, literature became the sole arbiter to the inconclusive data. The takeaway from this was that opinions, even informed opinions, are nothing more than experience-based heuristics. However, justifying discrepancies between opinions gathered from SME interviews proved to quite challenging and resulted in unanticipated delays in the thesis progress.

- **Choose your path carefully –** The NPS student's biggest educational career decision is the selection of a thesis topic. Selecting a thesis topic is usually based on personal experiences that motivate the researcher's interest. The overarching intent of this research was to enhance small-unit training and assessment methods to facilitate protecting military service members. The goal for this thesis was to objectively evaluate small-unit decision making performance in the IED-defeat domain.

    Selection of a ground combat-arms related thesis came from experiences relating to deployments to Iraq and Afghanistan. After witnessing some of the carnage and loss of life resulting from improvised explosive devices (IEDs), the topic was a means to confront my personal war experiences. Technological advances have improved the means to neutralize and defeat IEDs, but human ability lags considerably behind. Perception, interpretation, and recognition of IED emplacement characteristics are an enduring Marine training thrust. While the research goal was not meant to eliminate the evaluator's perspective, the focus was to overlay objective criteria on the trainer's assessment in order to structure the after-action review of training conducted.

B.   FUTURE WORK

During the creative process, contingencies arise which are never fully explored for a myriad of reasons. These discoveries are usually shelved for future work by subsequent researchers. For example, with the limited availability of SMEs, there were difficulties in substantiating the decision-making behaviors specific to the IIT training participants. Future research should develop and refine the behaviors under scrutiny through a controlled study or experiment. Having the specific behaviors, such as those

identified here, significantly correlated to training participants' performance will not only enhance the quality of the BARS development for the small unit decision making training. As shown in Table 7, the recommendations explore different avenues where the existing thesis research could be advanced.

Table 7.   Follow-on Research Recommendations.

RECOMMENDATIONS	DESCRIPTIONS
1. **Behaviorally-Anchored Rating Scales Experimentation**	This thesis research developed an empirical concept without statistically verifying the reliability or validity of the BARS. The next phase of this research would be to design a study to evaluate this BARS assessment method. The purpose of the experiment would be to determine the level of confidence in this assessment method compared to other approaches. Additionally, a study could involve multiple individuals as assessors to evaluate the reliability of the results.
2. **Behaviorally-Anchored Rating Scales Development in Alternate Infantry Immersion Trainer locations**	This BARS development process was only relevant to the Marine Corps Base Camp Pendleton (MCBCP) infantry immersion trainer (IIT). With two additional facilities at Camp Lejeune, NC, and Kaneohe Bay, HI, additional research could validate the BARS approach at the other IIT facilities. Additional experimentation could also assess the level of training effectiveness at each training range.
3. **Validation of Behaviorally Indicators for Small-Unit Decision Making**	Behavioral indicators of decision making were synthesized from six participants in the SME interviews. Complementary research could additionally determine the full-spectrum of behavioral indicators for a statistically representative population. The initial intent would be to make the indicators valid only to IIT facilities and then expand the research's scope to other training ranges.

This thesis research has two logical extensions to the current research methodology for the near-term (0-15 years), and long-term (>15 years) regimes. As shown in Table 8, the following are the natural projections of the research in those categorical timeframes.

Table 8.   Near- and Long-Term Future Work Recommendations.

RECOMMENDATIONS	DESCRIPTIONS
1. **(Near-Term) Behaviorally-Anchored Rating Scales Assessment Expansion**	The near-term recommendation of this BARS assessment methodology is to have the IIT trainers integrate BARS as part into their assessment process. Technological advances and improvements to the BARS would enable the IIT staff to iterate the BARS as scenarios evolved over time. Additionally, the incorporation of granular learning objectives to the scenario training run (establishing and securing cordon around a detected IED) would enhance the critique.
2. **(Long-Term) Decentralized Behaviorally-Anchored Rating Scales Assessment System**	The long-term recommendation for the BARS assessment methodology would be a technological incorporation that permits military organizations the ability to perform organic assessments of small-unit decision making. This would enable Platoon Commanders to use BARS to assess their platoon's decision making (and other) training without the need for external support.

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